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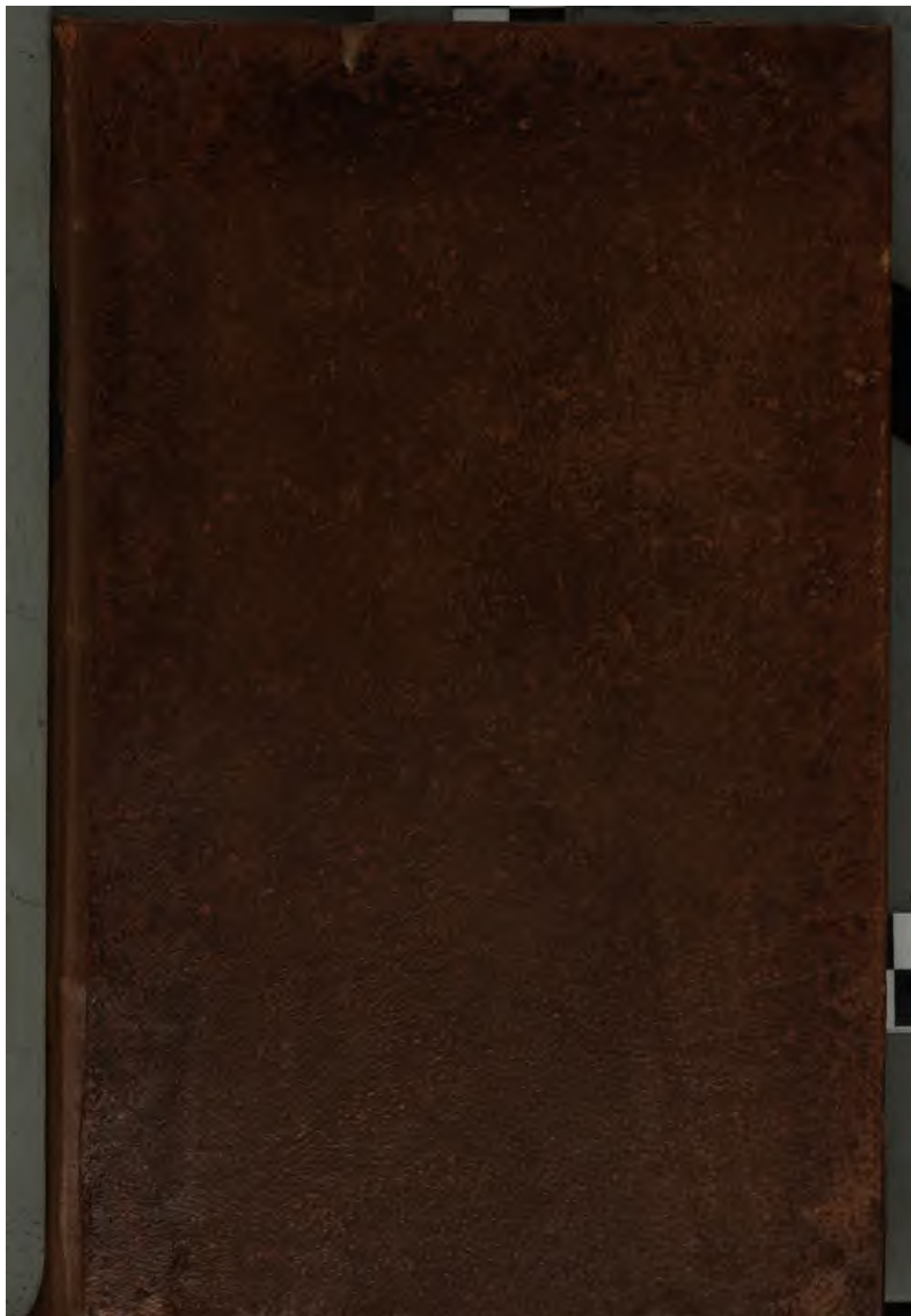
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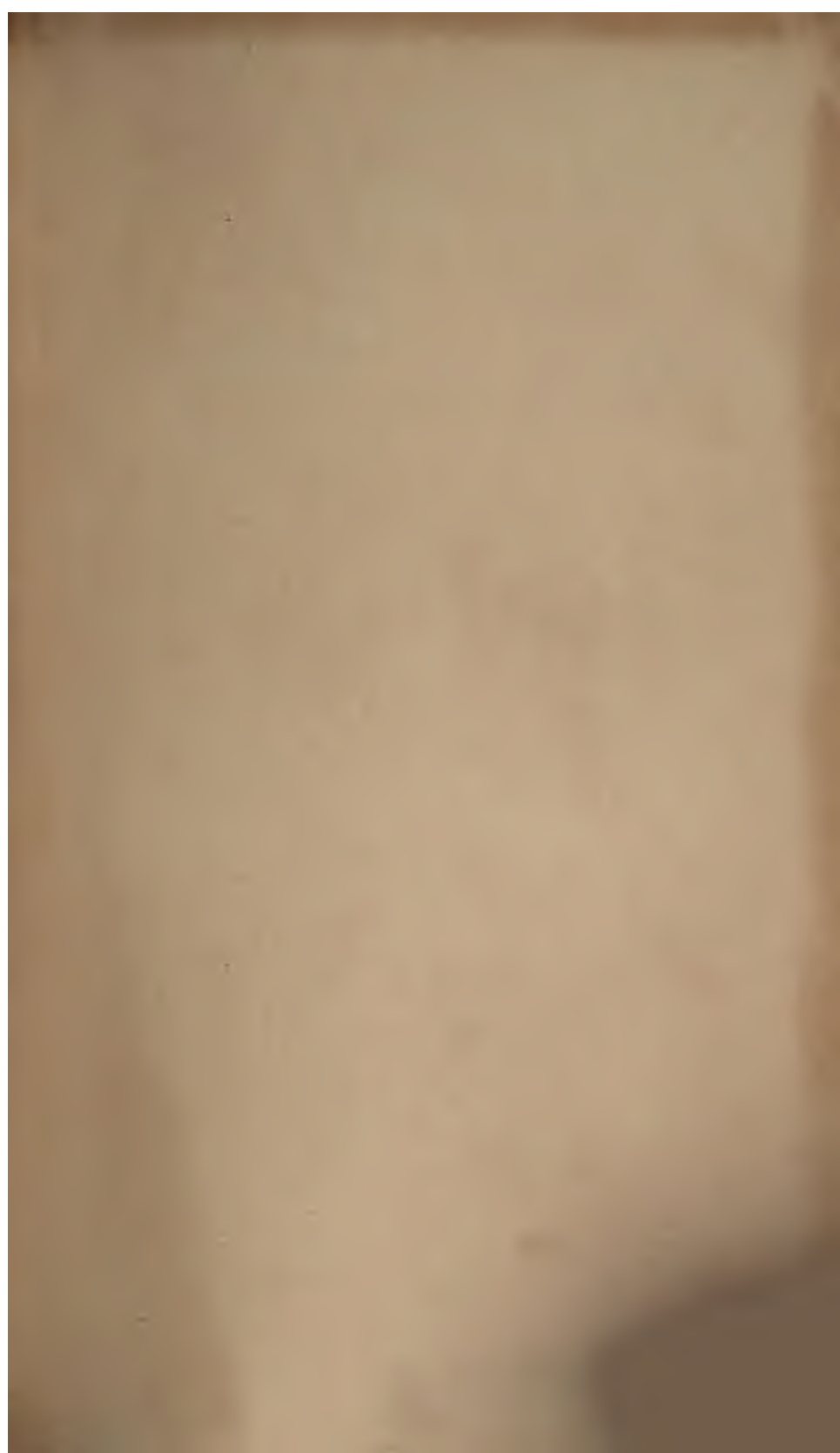


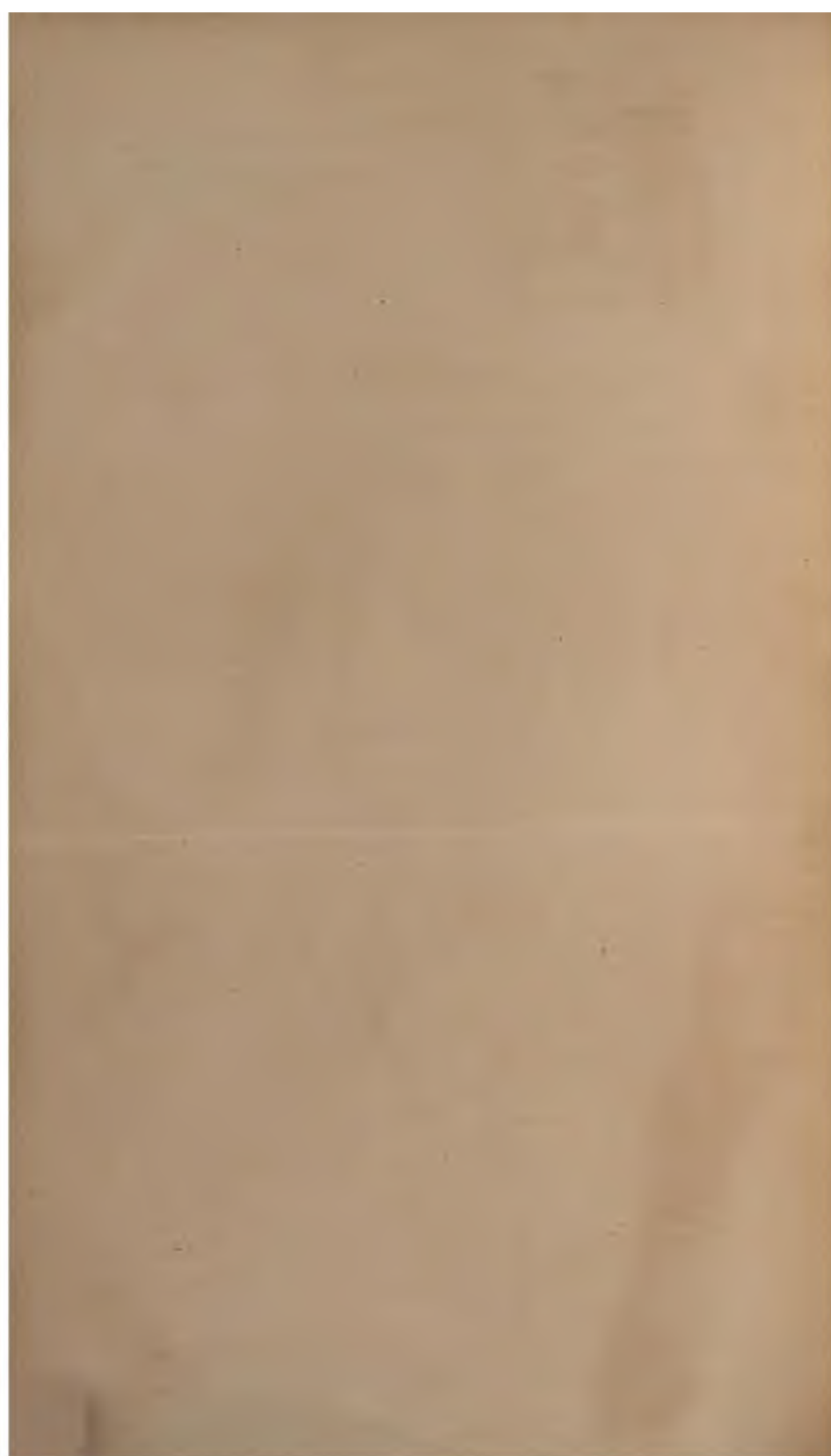
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LYMPHATIC VESSELS OF THE THORAX & ABDOMAN.

A TREATISE
ON
ANATOMY, PHYSIOLOGY, AND HEALTH
DESIGNED FOR
STUDENTS, SCHOOLS, AND POPULAR USE.

ILLUSTRATED WITH NUMEROUS PLATES.

By W. BEACH, M. D.

PROFESSOR OF CLINICAL PRACTICE IN THE ECLESIOTIC MEDICAL COLLEGE, CINCINNATI, OHIO.
AUTHOR OF THE AMERICAN PRACTICE, MIDWIFERY, &c.

"I am fearfully and wonderfully made."

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S. W. BENEDICT,
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TO
THE PROFESSORS
OF
The Cincinnati Eclectic Medical College,
THIS TREATISE IS RESPECTFULLY DEDICATED
BY THEIR OBEDIENT SERVANT,
THE AUTHOR.

INTRODUCTION.

I NOW present to the public my Treatise on ANATOMY, PHYSIOLOGY, and HEALTH, designed both for the student of medicine as well as the general reader. I at first intended to issue a large work and plates, to correspond with my midwifery ; but upon more mature reflection, I deemed it best to publish it in the present form and size, with the accompanying figures. The price of a work as large and costly as I at first contemplated, would have restricted the sale considerably, in placing it beyond the reach of those in limited circumstances. These objections, together with the great labor and cost of the text and engravings, have induced me thus to issue it ; and I think it preferable, taking everything into consideration. I have labored to be brief, perspicuous, and comprehensive, and, at the same time, to give clear and full illustrations, both by the text and numerous plates ; without which every work of the kind is very imperfect and poorly calculated to impart instruction.

The reader will perceive that I have adapted this treatise to the capacity of the popular reader, as well as the student of medicine. We must depend for patronage for a work of this kind upon all classes of the community ; and indeed the success of our reformatory course in medicine, I apprehend, depends much upon disseminating among them correct views in Physiology, which shows obviously the utility and importance of such a work. All classes are daily suffering from want of more information on those laws which govern

their organization, and which are constantly violated through ignorance. This fact ought to convince every one that there is a necessity of studying those laws, both to *prevent* and *cure* disease. The physiological inferences which I have drawn at the close of different chapters will be found, I believe, instructive and useful.

I lay no claim to any new discovery on the subject of Anatomy and Physiology. Both of these branches of medicine have been investigated and improved. But in consequence of a vast amount of useful matter scattered in various authors, mixed up with much that is very indifferent, I have consulted them *analytically* and *eclectically*. Hence, I have drawn my materials, as I have in my other works, from every available source. This has rendered it very difficult to condense the great amount of voluminous matter into the compass of the present volume. I have endeavored, however, to omit nothing really valuable, and at the same time have endeavored to present the subjects treated of in such a manner as to make the study of Physiology pleasing as well as instructive. How far I have succeeded I must leave to the candid and enlightened reader. As for the ignorant and prejudiced, I expect neither their good opinion or patronage.

If our Reform Schools of Medicine do not regard this treatise as a text-book on Anatomy and Physiology, I humbly trust that they will at least receive and recommend it as an elementary or preparatory treatise.

I will close these remarks in the language of Lawrence, in his introduction to his Lectures on Man: "I shall be satisfied, however, gentlemen, if you will accord to me the humbler merits—of industry, in collecting materials; patience in arranging, combining, and reflecting on them; fidelity and independence in exhibiting to you, precisely as they appeared to my mind, the inferences and deductions that resulted from the whole."

W. BEACH.

Anatomical Museum, New York, Sept., 1847.

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ANATOMY AND PHYSIOLOGY.

CHAPTER I.

PRELIMINARY REMARKS.

ANATOMY. The word anatomy is from the Greek, and signifies to cut, carve, or dissect. In an enlarged or extended sense it applies to men, plants, and animals. The latter is termed comparative anatomy.

Human anatomy may be comprised under two divisions, *namely*, ANATOMY and PHYSIOLOGY. First, a description of the organs, termed anatomical, giving an account only of their structure or organization. Secondly, of their uses, termed physiology.

The human system is composed of firm and soft parts, commonly called solids and fluids; of the solids, some are hard, others soft and flexible, they are the principal subjects of anatomy, properly so called. The solid parts are bone, cartilage, ligament, fibre, membrane, vessel, artery, vein, nerve, muscle, gland, fat, viscus, organ, &c. Bone is the hardest, most solid, and most inflexible part. Cartilage is a whitish or pearl colored substance, softer than a bone, smooth, polished, pliable, and elastic.

A *ligament* is a white, fibrous, compact substance, more pliable than a cartilage; difficult to be broken or torn; and yielding but very little when drawn out with force.

By *fibre*, is meant small filaments, which are the most simple parts of the body, and which compose all other parts; they differ in substance, direction, and size, according to the parts they compose.

By *membrane* we mean a pliable texture of fibres interwoven together; these are termed laminæ. Small portions of membranes, when very thin, are called *pelliculæ*; and this, when united to thicker membranes, is termed the cellular or spongy substance.

The adipose membrane is the same as the cellular, but the former is rendered impervious by the distension its contents occasion.

Vessels are tubes, composed of different membranes, the strata of which are termed tunica, or coats : they are named according to the fluids they contain, as blood-vessels, vasa lactea, lymphatics, &c. The smallest extremities of all vessels are generally termed capillaries. The blood-vessels are of two kinds; *arteries*, which carry the blood *from* the heart to every part of the system; and *veins*, which bring it back again *to* the heart. The arteries are thicker and deeper seated than the veins; the veins have valves which open towards the heart at different distances to prevent the blood from returning, but are not irritable like arteries, except the large ones near the heart.

By *nerves* are meant the white ropy parts or cords, which proceed from the brain and spinal marrow, and are spread over all the parts of the body, by small ramifications. They are the seat and origin of all our faculties, of sensation and motion.

The *muscle* is what we commonly call *flesh*, which is composed of various distinct portions : its white ends are termed tendon.

Glands are clustered bodies distinguished from other parts by their form, consistence, texture, connexion.

The kidneys, and the *pancreas* or sweetbread, are properly denominated glands.

Fat and marrow is that oily substance composed partly of cellular, partly of membranous, and partly of an unctuous matter; it is entirely deprived of sensibility, like all liquors secerned from the blood. Marrow differs only by its fineness, and from its being situated within the bones.

By *viscera*, is meant all the internal parts contained in the cavity of the body. Every part capable of any function is termed an organ.

In this work all the leading divisions will be the subject of a particular chapter.

CHAPTER II.

GENERAL VIEW OF THE HUMAN SYSTEM.

It may not be improper in the commencement of this treatise to give some observations on the human system in general, preparatory to an examination more in detail of the various organs.

THE BONES.

Say what the various bones so wisely wrought,
How was their frame to such perfection brought?
What did their figures for their uses fit,
Their number fix, and joints adapted knit;
And made them all in that just order stand,
Which motion, strength, and ornament demand?
What for the sinews spun so strong a thread,
The curious loom, to weave the muscles spread?

The Atheist, if to search for truth inclin'd,
May in himself his full conviction find,
And from his body teach his erring mind.

The use of the bones is to give shape and firmness to the body, levers for the muscles to act upon, and to defend those parts that are of the greatest consequence to be preserved, as the brain, heart, &c.

Bones are cast into a variety of moulds and sizes, strong to bear up the body, yet light, not to depress by their weight: bored, to contain the moistening marrow; and perforated with exceeding fine ducts, to admit the nourishing vessels; insensible themselves, they are covered with the periosteum, a membrane that warns of approaching injury, and preserves the muscles from being irritated by their action. Their figures are most precisely fitted to their uses; they are generally larger at the extremities than in the middle, that they may be joined more firmly, and not so easily dislocated; and the manner of their articulation is particularly curious.

The feet compose the firmest and neatest pedestal, far beyond all that statuary or architecture can accomplish; capable of altering its form, or extending its size, as circumstances require. They contain a set of the nicest springs, which assist to place the body,

in a variety of graceful attitudes, and qualify it for a multiplicity of advantageous motions. The heel has under it a tendinous substance, so tough as not to wear, and at the same time, to prevent the weight of the body from pressing too much on the finer vessels.

The legs and thighs are substantial columns, articulated in such a manner as to administer most commodiously to the act of walking: they swell out at the top, and are taper towards the bottom, which lessens their bulk at the same time that it increases their beauty.

The ribs form a regular arch, gently movable, for the act of respiration; they form a secure lodgment for the lungs, heart, &c.

The spine or back-bone is intended not only to strengthen the body, but also to bring down the spinal marrow from the brain. It guards, in a well-closed case, this vital silver. This fluid is thus communicated to each part of the body; had it been large, straight, and hollow, it might have done this; but then the loins would have been inflexible, and we should have been, as it were, impaled alive: to prevent this it consists of short bones knit together by intervening cartilages. This prevents dislocation, and gives this main pillar of our frame the pliancy of the willow, while it possesses the firmness of an oak. It is a kind of continued joint, capable of various inflexions, without injuring the medullary contents, and without intercepting the nervous fluid, which is to be detached from this grand reservoir, or diminishing the strength necessary to support the whole. A structure so singular in any other of the solids, would have been attended with great inconveniences, but is here a masterpiece of creating skill.

The arms pendent on each side are the guards that defend the whole body, and are fitted for the most diversified operations; firm with bone, yet not weighty with flesh, capable of performing with expedition and ease all useful motions; they move inwards, outward, upward, and recline downward; they wheel round, and can be placed in every situation we please. To these are annexed the hands, and both are terminated by the fingers, which are not, like the arms, of equal length and size, but in both respects different; which adds to their graceful appearance and utility. Were they all flesh, they would be impotent; were they all one bone, they would not be movable; but consisting as they do of various small bones and muscles, they answer every possible use, and being placed at the end of the arm, their sphere of action is considerably enlarged. The extremities of the fingers are an assemblage of fine

tendinous fibres most acutely sensible; and notwithstanding this delicacy, are in constant employ; but to protect them they are overlaid with nails, a horny expansion which hinders the flesh from being ungracefully flattened, and, like a sheath, preserves the tender parts from injury. The varied and delicate movements of these agents produce all the charms of instrumental music.

Above all is the head; a majestic dome, designed for the residence of the brain; it is framed in exact conformity to this important purpose; ample to receive it—strong to uphold it—and firm to defend it. It is screened from heat and defended from cold by a copious growth of hair; which also adds to its beauty, which nature is always attentive to, in subordination to usefulness.

LIGAMENTS.

The bones are tied together, those that have motion, by *ligaments*; a tough and strong arrangement of fibres, which also bind down some of the tendons, and give origin to the muscles; and render what would otherwise be an unwieldy mass, a well compacted and manageable system. The fleshy parts are often separated or connected by membranes, which are sets of fibres expanded, to cover or line other parts; such as the *Mesentery* and *Mediastinum* are membranes; the first connects the intestines; the last divides the thorax.

ARTERIES.

The ancients called the human body the microcosm or little world: and the arteries may be called its rivers; the blood is conveyed by the arteries to the head and every part of the system. When the left ventricle of the heart contracts, the blood is forced into the arteries, which then swell, and form what is termed the pulse; the heart and arteries dilate eighty times in a minute, which act occasions the beating we feel. The arteries carry their stream of vital fluid from the heart; the veins run all in a stream towards it; and because a wound or any impediment to the circulation in the arteries would be fatal, they are placed deep in the flesh, and can seldom be seen; so that the bending of the limbs does not stop their course.

VEINS.

In bleeding, the bandage is tied above the elbow, to prevent the blood passing towards the heart; and the median vein is cut;

whereas, if it were an artery, the band must be tied below the wound, for the tide would be going downwards, from the heart. The humeral artery lies under this vein, which it is dangerous to wound. Where the arteries *end*, the veins *begin* ; small at first, but gradually enlarging, they are void of pulsation, and as the force of the blood is not so strong in them, so their substance is thinner. When the blood is forced upwards, valves are provided to prevent its return ; and these open only one way, like valves in pumps. The blood in the veins moves seven hundred times slower than in the arteries.

GLANDS.

The glands have the office of straining from the blood various fluids, as the bile, saliva, urine, &c.

MUSCLES.

The muscles are those fleshy parts which perform the motions of the body ; and these are acted upon by nerves, which are surprisingly minute vessels, which pervade every part, and are the immediate objects of sensation. The white part of a muscle is called a tendon, which is composed of fibres, more compact and in less space.

SKIN.

The body is covered with a skin of the most delicate net-work, through the pores of which is discharged an insensible fluid continually ; the pores of the skin are so minute that a grain of sand would cover 125,000 of these little funnels, which are incessantly employed in carrying off a superfluous vapor from the blood. The discharge from the skin is upwards of three pounds daily of excrementitious fluid, and in quantity the evacuation by its pores exceeds that of the urine. Hence the importance of keeping this organ in a healthy state.

Nature does not forget beauty in her operations, and what can beautify our form more than the veins lying parallel to the skin, in those parts most conspicuous to public view—the pliant wrist, the taper arm, they variegate with an inlay of living sapphire. They spread vermillion over the lips, and plant roses in the cheeks—while the eye, tinged with glossy jet, or sparkling with cellular blue, rolls in polished crystal.

NUTRITION.

All these parts are in incessant action, which exhausts the fluids, and wastes the solids; to obviate this, the frame is endued with the powers of nutrition. The teeth prepare our food for this purpose; those in front, sharp and thin, to receive and cut the food; those behind, broad and strong, indented like the surface of a mill-stone, with small cavities, the better to fit them for grinding it. As milk is our food for some time after we are born, and as teeth would hurt the tender nipple, nature has wisely postponed the appearance of teeth until they become necessary. All our other bones are covered with a very fine skin, but this covering is omitted on the teeth, as chewing would then have been attended with exquisite pain. Had they been uncovered, they would have been subject to injuries from the air, and to the penetration of liquors that would destroy them, to guard against which they are curiously covered with a fine white enamel, harder than the bone itself.

Growing as they do in rows, numerous, and none rising higher than the other, they form a regular and beautiful addition to the mouth. To their aid, they also call in the tongue and lips, the latter keep the food in the mouth, while the tongue returns it to the renewed attrition of the grinders; the motion of the cheeks at the same time, with the stimulus of food in the mouth, presses out from a variety of reservoirs a moistening liquor necessary to prepare the food for digestion, as well as to soften and facilitate its passage into the stomach—when the mouth is inactive, these fountains are mostly at rest, but when we eat or speak their assistance is always ready.

As the food passes the wind-pipe, before it enters the œsophagus or gullet, there is a valve provided, which shuts on the approach of any substance, but the moment it has passed, it opens again; we all know what uneasiness is created by the smallest morsel going the wrong way; which if not thus guarded would expose us to instant death, by admitting any substance on the lungs.

The muscles of the gullet are contrived to pass our food quickly, but the stomach is constituted to retain its contents, which are lodged in the centre and made soft by the most kindly combination of heat and humidity. From whence, after being reduced to the most nicely mixed pulp, they are dislodged by a gently acting force and pass into the intestines; where, meeting the bile and pancreatic juices, it is passed by the vermicular, or *peristaltic*

motion of the intestines, through its various windings, and the *nourishing* parts of it all absorbed by the lacteals, and by them conveyed into the blood. These vessels are arranged in countless *multitudes* along the sides of the winding passage—they are so framed as to admit the nutrimental parts, and reject the gross and *useless* parts. The bowels are about twenty-five feet long, lined with a soft mucus, and having valves to prevent the aliment from returning back to the stomach; the substance of the bowels, though thin to a delicacy, is very strong; the skin of an ox-gut is said to bear the blows of a gold-beater's hammer for years.

BLOOD.

The *chyle*, drawn off by all the secretory orifices, is carried along millions of the finest ducts, and lodged in several commodious glands from whence it is conveyed to a common receptacle, and mounts through a perpendicular tube, called the thoracic duct. As this is the principal nourishment of the whole system, its conveyance is guarded with peculiar caution. The tube not having sufficient force of its own is laid contiguous to the great artery, whose *strong pulsation drives on the creeping fluid*, enables it to overcome the steep ascent, and unload its precious treasure at the very door of the heart. Here it enters a large vein called the left *subclavian*, most conveniently opened for its reception in an oblique manner, by which the reflux blood, assisted by a valve, expedites instead of obstructing its passage. This milk, this manna of nature, must be very acceptable to the blood, which has now been supplying every gland in the system, and further impoverished by supplying myriads of vessels with matter for insensible perspiration, yet, though thus kindly recruited, it is not refined. In its present state it is unqualified to perform the vital tour; therefore, by a grand apparatus of muscular fibres, it is wafted into the lungs, and pouring a thousand rills into either lobe in the spongy cells of their amazing laboratory, it imbibes the influences of the *external air*, giving out some useless parts, and imbibing some more necessary, and thus its heterogeneous parts are thoroughly incorporated. Here its *red color* commences, from the change it undergoes from the action of the air; and its whole substance is rendered cool, smooth, and florid. Thus improved it is transmitted to the left ventricle of the heart, a strong, active, unceasing muscle, placed in the centre of the system.* Impelled

* This wonderful machine will go night and day for eighty years together, at the

by that beating engine, part shoots upwards, and sweeps with a bounding impetus into the head, where it impregnates the prolific fields of the brain, and forms those subtle spirituous dews, the animal spirits, which impart sense to every nerve, and communicate motion to every limb. Part flows downward, and rolls the reeking current through all the lower quarters; and disperses the nutrimental stores even to the meanest member, and the minutest part. Thus the human river, with its incomparable rich fluid, laves the several regions of the body, transfusing vigor and propagating health through the whole. When this vital fluid, has pervaded every part, and given each his proper fluid, it is met by the ends of veins, and by them re-conducted back to the fountain. There it commences the same round; and the same force that darts the crimson wave from the heart, drives it also back again to it. Where opposite currents would be in danger of clashing, as in the ascending and descending great trunks of the veins, a fibrous excrescence intervenes, which, like a projecting pier, breaks the stroke of each, and diverts both streams into their proper receptacle. Thus modelled by the most judicious rules, and guarded by the wisest precautions, the living flood never discontinues its interchangeable tide, but night and day, whether we sleep or wake, still perseveres to sally *briskly* through the arteries, and to return *softly* through the veins. These are a few, and but a very few instances of that contrivance, regularity, and beauty, which are observable in the human frame. Attentive inquirers discover deep footsteps of design, and more refined strokes of skill,—discover them not only in the grand and most distinguished parts, but in every limb and organ; in every fibre that is extended, in every new discovered system of vessels, and in every globule that flows!

SENSES.

Having thus developed an organized body, endued with a principle of motion, and furnished with the power of nutrition, the sensitive faculties are now to be displayed. The functions of the mind are the effect of stimuli, as well as those of the body; and the more the mind is excited to action, the more is the vitality exhausted. The mind has a very great influence upon the body, and impressions made upon the one, instantly affect the other; the

rate of one hundred thousand strokes every twenty-four hours, having at every stroke a great resistance to overcome; and continue this action for that length of time without disorder and without weariness, whether asleep or awake. A perpetual motion.

principle that gives all our sensation, when much affected by the operations of the mind, becomes weakened, if the intellectual faculties are acted upon by reflection, or impressions of any kind to excess. It is not surprising, therefore, that debility of the system is induced from too much thought and intense study.

The creation abounds with objects fitted to yield the most refined entertainment—The *sun* impurples the robe of morning ; and *stars* bespangle the curtains of night. *Flowers* of silver whiteness, and golden lustre, enamel the ground. *Fruits* of every radiant hue, and every delicious taste, hang dangling on the boughs, but all in-vain to us, if kind providence had not endowed us with the powers of sense ; without which the breath of fields must lose its reviving fragrance, the whispering grove must degenerate into sullen silence, and nature's book of knowledge, all fair and instructive, would be no better than a vast unmeaning blank ; but providence, profusely gracious, has presented us with *senses*, the inlets of various delights, innumerable pleasures, and the most valuable advantages.

What though we trace each herb and flower
That drinks the morning dew ;
Did we not own Jehovah's power
How vain were all we knew.

HANDEL.

In an elevated situation, like a sentinel on a watch-tower, high in the head is placed the eye, bright and conspicuous as a star in the brow of evening, commanding the most enlarged prospects. Consisting only of simple fluids, inclosed in their tunics, it conveys to our apprehension all the graces of blooming nature, and all the glories of the visible heavens. An image of the hugest mountain, and a transcript of the most diversified landscape, enters the small circuit of the pupil. Its tender nature is guarded with most solicitous care—it is intrenched deep in the head, and barricadoed on every side with a strong fortification of bones. To guard its polished surface from the smallest fly, it is defended by two substantial curtains hung on a most slender cartilaginous rod : these are closed in sleep, and, on the approach of any danger, fly together quicker than thought. They are lined with fine moist sponges, as it were, which lubricate the eye-balls, and keep them fit for unwearied activity. The eye-lashes keep off the smallest mote, and moderate the too potent rays of the sun. The brows also break the force of it, and prevent the perspiration from offending them. The

arches are so finely colored, and so elegantly turned, that they set off the whiteness of the forehead, and bestow additional grace on the whole countenance.

The ear consists of the porch, or semicircular lodge, which stands prominent from the head, and is not soft and sinking as flesh, lest it should absorb the sound, rather than promote the repercussion; not hard and stubborn as bone, lest it should be painful when we repose, but is cartilaginous, with a tight expansion of skin, and wrought into irregular bends and hollows, which collect the sound and transmit it to the finely stretched membrane, the *tympanum*, so called because it resembles a drum in figure and use; being a fine skin expanded upon a circle of bones, and over a polished reverberating cavity. It is affected by the vibrations of the external air, as the covering of the drum is by the sticks. It is also furnished with braces, which strain or relax at pleasure, and accommodate its tension either to loud or languid sounds.

The avenue of the ear is secured by a viscous and bitter matter from the approach of insects. The winding labyrinths and the sounding galleries, etc., are all instrumental to the power of hearing, and are beyond description curious. The auditory tube softens and qualifies rushing sound, lest if the incursion were direct, it might by its impetuosity injure the delicate expanse of the tympanum; while, however, this is designed to moderate, the inner parts are prepared to heighten and invigorate the sounds, by means of an echo. Amazingly nice and exact must be the tension of the auditory nerves, since they correspond with the smallest tremors of the atmosphere, and easily distinguish their most subtle variations. They give existence to the charms of music, and reciprocate the rational entertainments of discourse. The eye perceives only the objects before it, but the ear warns us of transactions on every side. The eye is useless amid the gloom of night, but the ear admits her intelligence through the darkest medium. The eye is always on duty in our waking hours, but the ear is always ready to communicate any pleasure or danger.

Smelling conveys, by an expansion of the olfactory nerves, an idea to us of the quality of the particles wafted in the air. The nostrils are wide at the bottom, that a large quantity of effluvia may enter, narrow at the top that they may there act in a more vigorous manner. Fine beyond all imagination are the steams which exhale from fœtid or fragrant bodies. The microscope that can discover millions of animalculæ in a drop of putrefied water, cannot bring

one among all those evanescent legions to our sight. Yet so judiciously are the olfactory nets spread, that they catch the roaming perfumes which emanate from the opening flower, and absorb the stationed sweets which envelope the expanded rose. They imbibe all the balmy fragrance of spring, all the aromatic exhalations of autumn, and enable us to banquet on the invisible dainties of nature.

By *taste*, the food that supports our body, feasts our palate; first treats us with a regale, then distributes its beneficial recruits. The saliva flowing upon the tongue, and moistening its nerves, quickens them into the liveliest acts of sensation. Temperance sets the finest edge on its faculties, and adds the most poignant relish to its enjoyments. These senses are not only so many sources of delight, but a joint security for our health. They are vigilant and active inspectors.

To render the whole complete is added *feeling*: while other senses have a particular place of residence, *this* is diffused through the whole body, and is peculiarly fine at the extremities. Our feeling is finely tempered between the extremes; neither so acute as in the eye, nor so obtuse as in the heel; for the one would produce continual pain, and the other would quite benumb the body, and almost annihilate the touch. Indeed all our senses are most precisely fitted to our exigencies; were any strained higher, they would be the avenues of anguish; were they relaxed into greater insensibility, they would be useless incumbrances.

The *taste*, *touch*, and *smell*, are straitened in their operations, and perceive nothing but what is brought to their very doors. The *ear*, indeed, has a larger circle of objects; but the sight most amply supplies whatever is wanting in the others, spreading itself into an infinite number of bodies, and bringing to our notice some of the remotest parts of the universe.

The eye extends its observations as far as the orbit of the Georgium Sidus; nay, glances at an instant of time to the inconceivable distance of the stars—

"O'er all surrounding things that curious rove;
That loves the sky, uplifts its look sublime,
The stars peruses, and can clearly read,
In 'nature's various volume round it spread
In radiant letters writ, the Name Divine."

FAWCET.

But the crowning gift, which improves the satisfaction, and augments the beneficial effects accruing from all the senses, is

speech; this makes us gainers from the eyes and ears of others, from the ideas they conceive and the observations they make. The tongue has neither bone nor joint, yet fashions itself with the utmost volubility, into every shape and posture, which can express sentiment, or constitute harmony.

By this little collection of muscular fibres, we communicate the secrets of the breast, and make our thoughts audible. By this we should instruct the ignorant, comfort the distressed, glorify God, which is its noblest employ, and benefit each other.

As the tongue requires a full scope and easy play, it is lodged in an ample cavity, and surrounded with reservoirs of spittle (saliva), always ready to distil the lubricating fluid. It moves under a concave roof which serves as a sounding board to the voice, giving it much the same additional vigor and grace as the shell of a violin adds to the strings. The notes of the human voice,* so far as they can reach are the most agreeable of all musical sounds.

THE MIND.

However we admire this multiplicity of animated organs, their finished form, and their faultless order; yet admiration must rise higher when we recollect the mysterious power and sway the soul has over them. Ten thousand reins are put into her hands; she is not acquainted with their offices, their use, or their name, yet she manages all without perplexity; the manner in which the will acts upon the system, or how, or by what means, so many functions are managed independent of the will, or that a variety of exertions should be made without inconvenience to us, we know not†—all we can do is to exercise our wonder and gratitude for so many circumstances, which all administer to our comfort.

SOCIAL AFFECTIONS.

A celebrated poet remarks, that the proper study of mankind is man: and this study originates from the smallest beginnings,

* Lavater considers the human voice as an indication of character. See Vol. I, p. 49; Vol. II., p. 54, 8vo. edition. Robinson's, 1789.

† "The principle of muscular motion, viz. upon what cause the swelling of the belly of the muscle, and consequent contraction of its tendons, either by an act of the will, or by involuntary irritation, depends, is wholly unknown to us. The substance employed, whether it be fluid, gaseous, elastic, electrical, or none of these, or nothing resembling these, is also unknown to us. We see nothing similar to this contraction in any machine which we can make, or any process which we can execute." Cuvier's Lectures, Translated by Mr. Ross, 2 vols., 8vo., Longman, 1802—a work displaying an infinite variety of facts relative to *Comparative Anatomy*.

enlarges as the faculties of the mind unfold themselves, and comprehends in its progress all the powers and principles which actuate human nature, through the successive stages of existence. In infancy, the appetites and senses are developed, exercised, and strengthened; they give information of surrounding objects, excite attention, complacency, surprise, and admiration; and the notices they bring are treasured in the store-house of the memory. By the frequent repetition of agreeable impressions, certain objects become pleasing and familiar to the young spectator. He distinguishes his parents, brothers, and sisters; is uneasy when they are absent, and delighted to see them again. These emotions soon constitute a moral attachment, which reciprocal endearments heighten, gratitude confirms, and habit renders indissoluble. The amusements of *childhood*, and the active pursuits of *youth*, add, every day, some new link to the great chain of social love.* Connexions are multiplied, common interests established, mutual dependencies created, and the principles of sympathy, friendship, generosity, and benevolence acquire vigor by exertion, and energy by being uncontrolled. The powers of the understanding and imagination now expand themselves; curiosity is awakened, and directed to other objects besides those of sense; emulation rouses; the thirst of knowledge stimulates, and the taste for beauty, in all her varied forms, allures the mind to study and contemplation. The scenes of nature at this period of life are viewed with peculiar admiration and delight; and the signs of order, wisdom, and goodness, which are everywhere discerned, should elevate the ideas to the great parent of the universe. Devotion glows in the heart, reverence fills the thoughts, and piety exalts the soul to an intercourse with God.

Cherish, generous youth, the sacred flame, thus kindled in thy breast—it will be a light to thy feet, and a lamp to thy path; will illuminate thy faculties; cultivate thy virtues; add lustre to thy prosperity; and dispel, with cheering beams, the gloom of sorrow and adversity.

In manhood, the pursuit of wealth or of honor, the diversified offices of each particular rank and station, call forth into exertion other passions, or vary the force and direction of those already experienced.

OLD AGE.

Old age at length creeps slowly on:† the generous affections

* Percival.

† According to a calculation founded on the burial registers, only one man out of

abate in their vigor and warmth, and anxiety, suspicion, fearfulness, and the love of money, by insensible degrees, too often take possession of the mind. Life often increases in value the nearer the conclusion of it approaches; and the means of enjoyment become most prized, when the end, for which they are designed, ceases to be attainable. Such are generally the weaknesses of declining nature; which, though wisdom condemns, she forbids us not to pity.

"The *seven* first years of life, man's break of day,
Gleams of short sense, a dawn of thought display:
When *fourteen* springs have bloom'd his downy cheek,
His soft and bashful meanings learn to speak:
From *twenty-one* proud manhood takes its date,
Yet is not strength complete till *twenty-eight*;
Thence to his *five-and-thirtieth*, life's gay fire
Sparkles and burns bright in fierce desire:
At *forty-two* his eyes grave wisdom wear,
And the dark future dims him o'er with care:
With *forty-nine* behold his toils increase,
And busy hopes and fears disturb his peace;
At *fifty-six*, cool reason reigns entire,
Then life burns steady and with temperate fire;
But *sixty-three* unbends the body's strength
Ere th' unwearied mind has run her length;
And when from *seventy* age surveys her last,
Tir'd she stops short, and wishes all were past."

Thus we see the life of man in its different stages; it begins from the cradle; pleasing childhood succeeds, then active hot-blooded youth—afterwards manhood, firm, severe, deliberative, and intent upon self-preservation; lastly, debilitating old age steals on with silent steps, and renders us a *foetus* of eternity!

Happy is he who, having studied the complicated history of man, knows the subordination, and holds the balance of his several moral and intellectual faculties; who can gratify and yet regulate his appetites; indulge, but moderate his passions; and setting bounds to all, maintain inviolate the supremacy of reason.

To conclude—What a multiplicity of the operations of the system! Some fluids move slowly, others faster, others with the celerity of electricity or lightning: as the blood running into ten thousand rivulets, pouring into every part of the body with great power; hundreds of muscles ready to obey the will with instantaneous speed; and then, above all, the powers of the 3,125 lives to a hundred years of age.—Chronolog. Tablets, Vernor and Hood, 1801. It is calculated that on the globe 500,000 human beings die every day!

mind—all proclaiming the power and omnipresence of Deity, who carries this globe and its furniture eighty-six thousand miles per hour.

On reviewing the mechanism of the heart, for instance, every reflective mind must be struck with the admirable adaptation and suitableness of its several parts, and also the harmony of its operations. How important is the least part of its complex machinery! If but a thread connected with the valves be broken, or one of its slightest members burst; if a single valve omitted to fall down before the retrograde current of blood, or become inverted, the vital functions could no longer be carried on; the vast machine of the whole animal frame would be immediately deranged, and death necessarily ensue. Who would suppose that an apparatus so complex, so easily disarranged, and which is thrown into action considerably more than 100,000 times a day, should continue unimpaired, by day and night, sleep or awake, for eighty or one hundred years, constituting, as it were, a perpetual motion!

There is a variety and elegance in the texture of the human frame, in the formation and arrangement of the bones and muscles, the arteries and veins, far beyond any comparison, all acting together in such a mysterious way as to render us a wonder to ourselves.

God of perfection! how benevolently hast thou displayed thyself in man! Behold the human body! that fair investiture of all that is most beauteous. Unity in variety! variety in unity! What elegance, what propriety, what symmetry through all the forms, all the members! How imperceptible, how infinite are the gradations that constitute this beauteous whole!

How sublimely does Shakspeare express himself—"What a piece of work is man! how noble in reason! how infinite in faculty! in form and moving how express and admirable! in action how like an angel! in apprehension how like a god!—the beauty of the world, the paragon of animals!"

Says Feltham—However elevated and curious the study of any part of the visible creation may be, and though every branch of natural philosophy alike displays the benevolence and perfection of the Deity, yet of all the parts of science, our present researches are justly entitled to a pre-eminence.

Consider the parts and structure of the body! Is not the body of man the noblest piece of animal mechanism possible in nature? does it not really transcend the power and thought of man to

imagine any form or structure more perfect, more elegant, more grand and commodious? What do you judge of man's erect posture? his beauteous shape? his proper stature? the structure and accuracy of its parts? the fitness of every part to its office and end? What sparkling brightness in the eyes! what sweet melody in the voice! how quick the ears to receive all manner of sounds! how nicely adjusted are the palate and taste to all sorts of food! What a noble instrument is the tongue! hence speech and eloquence, oratory and persuasion. What wonders appear in the *hand* of man! its formation and astonishing variety of uses! what majesty in the *face*! how immensely different are the countenances of men! what endless differences in their voices and hand-writing! What a striking proof of God in the *soul* of man!

The powers of man's mind show him to be almost a divine existence. He thinks; he is conscious of internal acts; he forms ideas of all things; he reasons on his thoughts; he perceives an infinite variety of objects; he reflects on these images of things in his mind; he re-collects his thoughts, and surveys their agreement with objects and their difference from each other; he brings all past ages, and time present, to his mind, and views the transactions of men and revolutions of empires for thousands of years; he can recollect a thousand, ten thousand, a million facts at once; he makes them pass in quick succession before the eyes of his mind; he marks the different natures and tendency of men's actions; sees how one kind have a direct influence upon his peace and happiness, while others issue in ruin, devastation, and death. He commands the future time to the present view of his vast and mighty mind; foretells the consequences of actions; penetrates the dark veil of future ages, calculates or predicts the wonders of an eclipse for hundreds of years past or to come, and dives into the condition of men for ten thousand years to come. He pursues a mental tour round the earth, and ranges his thoughts all over the skies: he roves from planet to planet, from sun to sun, from world to world, almost to infinity! How great is the resemblance of the human soul to God! His existence and omnipresent agency is clearly seen in it. The invisibility of the soul demonstrates the invisible God.

CHAPTER III.

THE BONES.

OF all the parts of the body, the bones require to be first considered, because they form the frame-work whereon all the soft parts are fixed, and determine the shape and size of the whole. They are the hardest and most durable part of the body, and are found existing ages after all the rest has long mouldered into dust. This hardness and durability depend on the large proportion of inorganic matter which enters into the composition of bony tissue, the great quantity of lime which is mingled in it. The animal and earthy parts of bone can be easily separated and demonstrated in a separate state. If a piece of bone be immersed for a day or two in diluted muriatic acid, the earthy part will be completely dissolved out, and the animal part will be left, yet the bone will still have the same size and the same shape, so intimately are the two different materials blended together, and may be tied in a knot as represented in the following figure. If it be now dried and weighed it will



be found to have lost nearly two-thirds of its original weight, the loss consisting of the earthy particles. The substance now obtained is the cartilage of bone, which is very nearly the same in composition as the cartilages which we find ready formed by nature in the body. It is much softer than bone, but harder than any of the other soft parts; it is highly elastic, and if compressed or bent, speedily regains its original shape. When dried, it assumes a darker color, and becomes hard and tough, translucent, and very like horn. When boiled, this substance is nearly all dissolved,



FIG. 1 A FRONT VIEW OF THE MALE SKELETON.

HEAD AND NECK.

- a, The frontal bone.
- b, The parietal bone.
- c, The temporal bone.
- d, A portion of the sphenoid bone.
- e, The nasal bone.
- f, The malar, or cheek-bones.
- g, The superior maxillary, or upper jaw.
- h, The lower jaw.
- i, The bones of the neck.

TRUNK.

- a, The twelve bones of the back.
- b, The five bones of the loins.
- c, d, The breast-bone.
- e, f, The seven true ribs.
- g, h, The five false ribs.
- i, The rump-bone or sacrum.
- j, The hip-bones.

UPPER EXTREMITY.

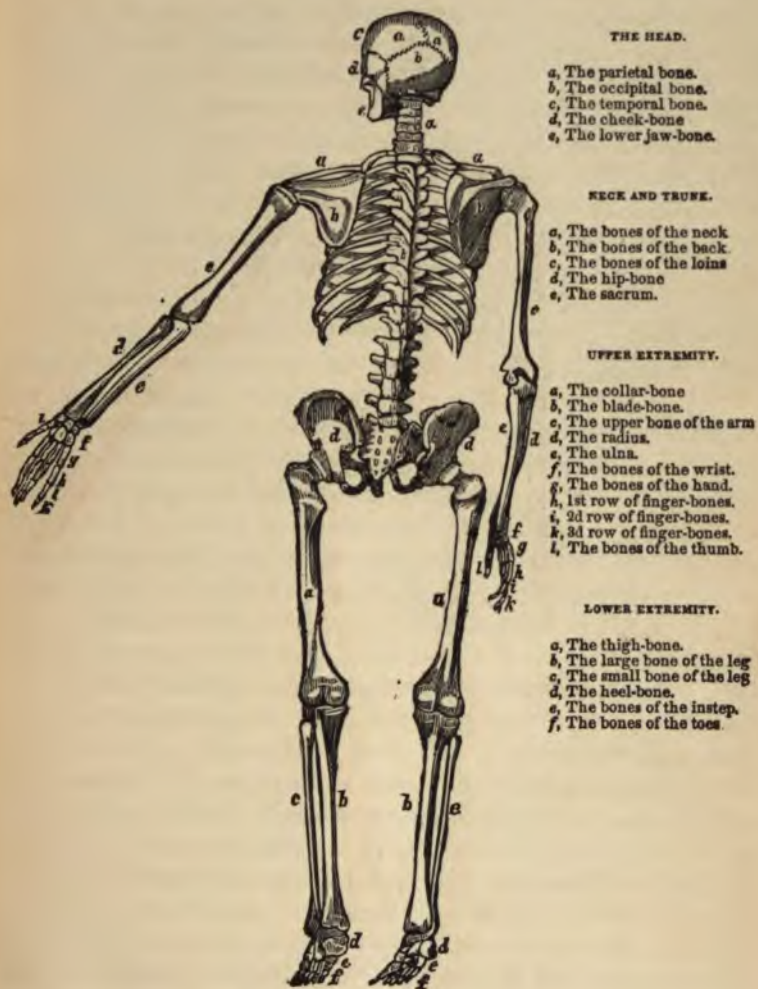
- a, The collar-bone.
- b, The shoulder-blade.
- c, The upper arm-bone.
- d, The radius.
- e, The ulna.
- f, The carpus, or wrist.
- g, The bones of the hand.
- h, 1st row of finger-bones.
- i, 2d row of finger-bones.
- k, 3d row of finger-bones.
- l, The bones of the thumb.

LOWER EXTREMITY.

- a, The thigh-bone.
- b, The knee-pan.
- c, The tibia, or large bone of the leg.
- d, The fibula, or small bone of the leg.
- e, The heel-bone.
- f, The bones of the instep.
- g, The bones of the foot.
- h, 1st row of toe-bones.
- i, 2d row of toe-bones.
- k, 3d row of toe-bones.



FIG. 2. A BACK VIEW OF THE MALE SKELETON.





yielding a firm transparent jelly; and it was a knowledge of this property which suggested to Papin the invention of his digester, in which, by boiling bruised bones under strong pressure, the jelly is obtained, and a large quantity of strong soup is made from what would otherwise be entirely worthless. The earthy part of the bone is demonstrated in a different manner. If a bone is put into a clear fire, and heated to redness, the animal part is entirely consumed, and a white friable earth is left behind. This earth consists almost wholly of lime, in combination with phosphoric and carbonic acids. It is on this account that phosphorus is obtained from calcined bones. There are minute portions of other salts in the earthy part of bones, but these it does not seem necessary to mention in detail. When a bone has been thus treated, and is weighed, it will be found about one-third lighter than at first, the loss consisting of the gelatinous part. And as was remarked of the gelatinous part when obtained by itself, so also the earthy part has exactly the original shape of the bone, and the most minute bony threads are still seen existing.

In consequence of the entry of these two very different substances into the formation of bone, it is both hard and elastic; the earthy part bestowing the density, the animal part the elasticity. The hardness is indeed its most remarkable property, in consequence of which it has that firmness and resistance by which it is so admirably adapted for the offices it has to perform in the animal machine. The hardness varies a little in different parts of the body, and usually increases with age. Bones are somewhat flexible and elastic, this elasticity varying however in different situations. We find that the ribs may be much bent, and afterwards recover their form perfectly. Hence boys have used a horse's rib for a bow. This elasticity frequently saves them from fractures, and lessens the shock which would otherwise be communicated to the delicate structures which they defend. It was remarked above, that in old age the hardness increases, and at the same time the elasticity diminishes, and hence the reason why elderly people are much more liable to have their bones broken than young ones. A child may often get a twist which will bend one of the long bones, but instead of breaking, it recovers its proper form, if not immediately, at least shortly after; while in an old person, any such twist is almost invariably followed by a fracture. The color of bone in the living person, is a pale rose color, inclining in early life to red, and in old age to a yellowish white. When bones are long macerated

in water, so as to remove entirely the blood and oil which pervade them, they become of a beautiful white.

As bones are living parts, they of necessity are provided with blood-vessels and nerves. On the surface of every bone may be remarked an infinity of minute pores, into which small blood-vessels run. If the surface of a bone be exposed in the living body by an injury, it will be seen to bleed, and it can be colored artificially. This coloration, however, is practicable only in young subjects, where a great afflux of blood takes place to the bones, for their growth; in adult years, when they have reached their full size, and have become hard and compact, much less blood in proportion circulates through them. There is another very curious way in which the vascularity of young bones can be demonstrated, by making the blood itself the vehicle of the coloring matter with which they are to be injected. If a young growing animal be fed for a fortnight or so, on food in which a proportion of chopped madder is mixed, the coloring principle of the madder will pass into its blood, arrive in its bones, and there chemically combine with the lime, tinging the bones of a beautiful rose color, which is permanent, even after the bones have been cleaned and well washed in pure water. The nerves which are distributed to bones are very trifling, so that in the healthy state they may be said to be almost insensible; but when they become inflamed, their sensibility is so much exalted, that the slightest touch causes excruciating agony.

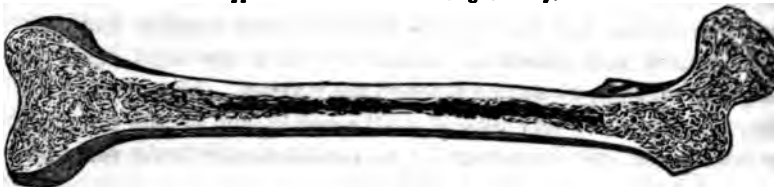
The bones are covered with a dense membrane called the periosteum, which adheres strongly to them, serves to convey the blood vessels to them, and sends prolongations into all the little holes which exist in such numbers on their surfaces. It also serves as the medium for the attachment of tendons and ligaments to them, having these parts in a manner interwoven and confounded with its outer surface. The periosteum has also a considerable share in the growth of young bones, and in the growth or reparation of old ones, when fractures or other injuries may have rendered that necessary.

Bones assume every variety of shape, as may be expected from the various places and offices which they are destined to fill. These varieties have been reduced by anatomists to four classes: 1st, the long or cylindrical; 2d, the broad or flat; 3d, the short or round; and 4th, the mixed or irregular. The long bones are distinguished by their length, which greatly exceeds their other dimensions. They are found only in the extremities, and are

adapted for locomotion, and for sustaining the weight of the body. They are never exactly cylindrical, being smallest about the middle, and enlarged at each end. The broad or flat bones are generally somewhat arched, and fitted to protect delicate organs; we find the best specimens of them in the cranium. The short bones are of irregular figures, but all somewhat roundish; they are found in the wrist and the instep of the foot. The mixed or irregular bones are usually classed with the short, but it is better to separate them; the bones of the spine are the best examples of these. The ribs and bones of the pelvis may also be ranged with them, combining the characters of the two preceding classes.

If we prepare bones by careful maceration and drying, so as to remove all the grease from them, and then saw them up, we observe the density of the osseous tissue to differ very much in different parts. The outer part is much harder and denser than the internal part, and is called the compact substance. The internal part is of a looser texture, and is called the cancellated or spongy substance. These tissues are arranged differently in the different orders of bones.

Appearance of a bone sawed longitudinally.



In the flat bones, the compact substance is arranged into two layers, separated by a thin stratum of cancellated structure, in which the blood-vessels of the bone run. Where the bone is very thin, the two outer layers are in contact, or appear compressed into one, and the intermediate layer has disappeared. In the round bones, there is a very thin layer of compact tissue on the outside, while the internal part is composed of spongy tissue. In consequence of this predominance of spongy tissue, and consequently of blood-vessels, the round bones are much more liable to inflammation than any of the others. The long bones consist of three parts, a shaft, and two extremities; the shaft consists of very dense compact tissue externally, becoming looser internally, and having a canal running through them, nearly from end to end; while the extremities are of the same structure as the short bones. The canal which runs through the long bones is lined with a delicate mem-

brane, in which is contained the medulla or marrow. The medulla is in young persons of a bloody nature, in old persons it is oily. The canal serves to make the bone much stronger than if it were solid with the same quantity of material; on a principle which is well understood by machine makers, who often make use of hollow pillars and shafts, to gain additional strength without additional expense. The marrow is put into the canals, not to oil the bones, as many people erroneously suppose, but because there is no empty space permitted in the body, and fatty matter is the lightest that could be used for filling them. Besides, the marrow serves the same purpose as the fat in other parts of the body; it is a store of nourishment whence the body can be supported when unable to take any nourishment from without. In fevers, for instance, where the patient scarcely tastes food for perhaps three weeks, he is maintained on the superfluous parts of his own body, and hence the sunken cheeks and shrunk shanks of such a sufferer when beginning to recover. That this marrow is not of any use to the bone itself is sufficiently proved by the fact, that in birds there is none, but the bones are very thin and their canals large in order to be light, and instead of marrow, they are filled with air. There is a common notion that the marrow is exceedingly sensible, and persons remark how painful the application of a saw must be in an amputation, from its tearing through the marrow. Now the fact is, that the marrow is very little if at all sensible, and all the pain felt in sawing the bone is a sort of jarring communicated to the soft parts which have been already divided.

The irregular bones, resembling in shape two or more of the preceding orders, have some of their parts resembling the round bones, and others resembling the long and flat.

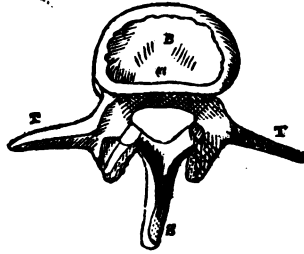
Where the bones touch one another, they are particularly smooth, and their surfaces are adapted to one another. Besides, to obviate friction, they are covered at these places with cartilage or gristle. Cartilage is intermediate in hardness to bone and what are properly called the soft parts, it is firm and resisting, and yet it has a great degree of elasticity. In some parts of the body we have cartilages serving for continuations to bones, such as these which continue the ribs, and connect them to the breast-bone, and they are exactly similar to bones from which the earthy part has been dissolved out by an acid. But the cartilaginous crusts which cover the articular ends of bones are of a very beautiful and peculiar structure. When a portion of bone with its cartilage has been macerated in water for

some weeks, the cartilage is found to have lost its cohesion and its smooth surface, and appears exactly as if the bone had been covered with white velvet. It is seen to consist of an infinity of fibres set perpendicularly on the surface of the bone, so that when pressure is made on their ends, they yield by bending a little sideways, but are prevented from yielding much, by the closeness with which they are set together. In effect, the result is just what is seen on a larger scale, if the finger is pressed against the surface of a common flat cloth brush, the bristles bending a little sideways, and so presenting an indentation on the surface.

The account which has now been given of the nature of bones, as a tissue, is applicable not only to those of man, but of all the other mammalia, and of birds. In the arrangement of the bones, however, every species differs from the rest, according to the purposes which its body and limbs are to serve. The bones united in their places constitute the skeleton.

The **SKELTON** consists of the *head*, *trunk*, and *extremities*. The trunk is composed of the spine, the ribs, the sternum or breast-bone, and the *pelvis*, supporting the head upon its upper end, and resting its lower end on the heads of the thigh-bones. The extremities are four, two superior, commonly called in man the arms, two inferior, commonly called the legs; but in strict anatomical language, the word leg is applied only to the part below the knee, the part above being always spoken of as the thigh; and the part above the elbow only is called the arm, the part below the elbow being the forearm. We will now examine these parts in succession more minutely.

The spine is the central column, resting on the pelvis and thigh bones, and supporting the chest, the head, and the superior extremities. It is about one third of the length of the whole body, so that in a man who stands six feet high, the spine will be found about two feet long. It consists of twenty-four pieces or vertebræ, named from the Latin word *vertere*, to turn, on account of their mobility. The largest is placed below, and they diminish gradually to near the top. Each vertebra is a mixed bone in its structure, and has a body and processes; the word process in anatomy signifying a projection or prominence. The body of each vertebra is of the nature of a short bone, spongy in its texture, and very light. It is semicircular, or nearly so, flat above and below, where it supports and rests upon its neighbors. In the accompanying cut, B represents the body of the vertebra with its flat surface



turned towards the reader. From the back of the body, the arch, A, of the vertebra springs, enclosing a space which is occupied by the spinal marrow. Then to serve as levers, for the purpose of bending and turning the spine, we have two transverse processes, passing out one on each side, and the spinous process passing backward, forming the chain of projections felt under the skin, which give the name to the whole column. These four-and-twenty pieces are joined together, so as to allow of a little motion, and but little, at any one joint, that the spinal marrow which passes down through the canal formed by the apposition of the different rings, may not be injured by too sudden a twist, but that the curves which it forms in the various motions of the body may be gradual.

Even when at rest, the spine is not straight, but curved in three different places. First, it curves forward where it rests on the pelvis, that it may not be exposed to too rough a shock when we begin to move, from being in a state of rest. Secondly, it curves backward in the region of the back, to increase the capacity of the chest, in which the heart and lungs are to be lodged. Thirdly, it curves forward again in the neck in order to bring the weight of the head which rests on it, over the point of support between the feet. Three regions are distinguished in the spine, first the cervical, or that of the neck, consisting of seven vertebræ; second, the dorsal, or that of the back, consisting of twelve; and third, the lumbar, or that of the loins, consisting of five. The vertebræ of the loins are the most movable; it is here that the turning and bending of the trunk chiefly take place, and consequently it is to this region that injuries are the most apt to occur.

To the twelve vertebræ of the back the ribs are attached, twelve on each side, in order to form the chest. It has often been asked whether it were true that men had a rib fewer than women, in consequence of the rib having been taken from Adam's side of which his wife was to be formed. Of this it may be said, that

whatever the deficiency was in Adam's own person, it has not descended to his male children.

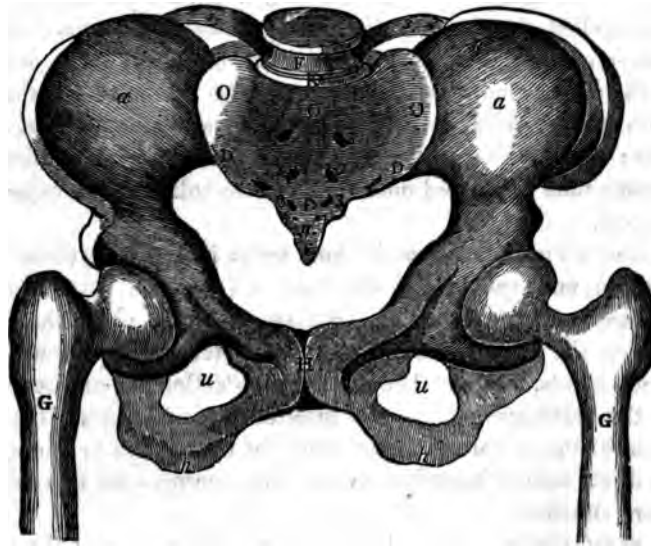
The ribs become gradually longer from the first to the seventh, and from that shorter again to the twelfth. The ten upper ribs are connected to the sternum or breast-bone in front, by means of their cartilages, which it has already been remarked, give elasticity to the walls of the chest. The lowest two, which are not attached in front, are called the floating ribs. The heads of the ribs behind are connected to the vertebræ by a kind of hinge joint, which allows the ribs to move up and down in the action of breathing. Each rib passes from its attachment downwards, outwards, and forwards; so that when lifted up by the muscles of inspiration it at the same time is carried outwards, and so enlarges the capacity of the chest.

The sternum or breast-bone is about seven inches long, about two broad above, and one below, and ends in a movable point formed of cartilage. It is smooth and convex in front, gives the prominence to the front of the chest, and projects conspicuously in some individuals, who are thence commonly called pigeon-breasted. It has the cartilages of the ribs inserted into its edges; it has a hollow in its upper part to make room for the trachea or windpipe to pass down behind it, and to its two upper corners the two collar-bones are attached.

The chest viewed as a whole, is conical, the apex of the cone being above, and the base below; the aperture above is small, about four inches across, and two from before backward, allowing the windpipe and œsophagus, or gullet, and the great veins of the arms and head to pass down, and their arteries to pass up. The inferior opening of the chest is large, and is filled by a muscle named the diaphragm, a Greek word which literally means the partition, because it separates the belly from the chest; forming a roof for the one, and a floor for the other. The chest is considerably deeper behind than in front, and the edges of the cartilages of the ribs can be felt, and in a thin person seen, passing upwards from the flanks, and meeting at an angle at the breast-bone, leaving a hollow between them, which is known as the pit of the stomach.

The next division of the trunk is called the *pelvis* or *basin*, which consists of a circle of large firm bones, situated between the lower portion of the trunk and the inferior extremities. They are the sacrum, the coccyx, the ilium, the ischium, and the pubis. The ilium forms the upper, the ischium the lower, while the pubis is

situated at the fore part of the pelvis; and each one of these bones contributes to form the large and deep socket, for the head of the thigh bone. The pelvis not only affords lodgment for the organs contained within its cavity, but it also sustains the entire weight of the body, and furnishes sockets for the heads of the thigh bones to roll in, and a broad surface for numerous muscles to spring from.

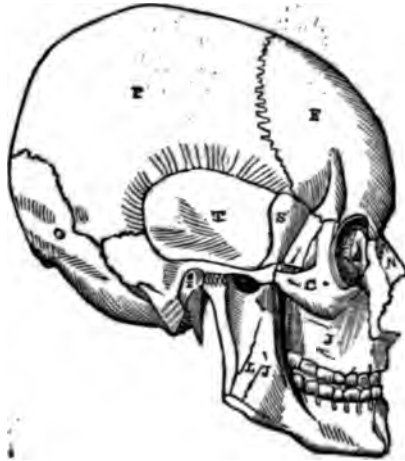


a a. Ilium. E. Os Coccyx. G. Femur. H. Pubes. u u. Foramen ovale.

The pelvis is so named, because it is somewhat like a basin, only it has a wide aperture in the bottom, through which the canals from the bowels, the bladder, and in the female from the womb, make their exit. It consists of three pieces, two haunch-bones and the rump-bone, in vulgar language.

The head is placed upon the end of the spinal column, in order that the brain which is contained in it may be connected with the spinal marrow; and upon its upper end, that the eyes which are set in it may enjoy the widest possible range. It consists of two parts, the cranium and the face; the former for containing the brain, the latter for the organs of sight, smell, and taste. The cranium is very nearly of the shape of an egg, the large end being backward, and the small one forward, presenting thus the characters and having the strength of a double dome. The upper dome is stronger, however, than the lower one, and hence we find that when a man falls from a height on his head, the fracture is most

frequently not at the part struck, but at the base, where it is completely out of the reach of the surgeon. The face cannot be compared to any known regular form; it is excavated by several cavities, one large one for the mouth, another of considerable size for the nose, and two smaller pyramidal ones for the eyes, called the orbit. The number of bones in the head is twenty-two.

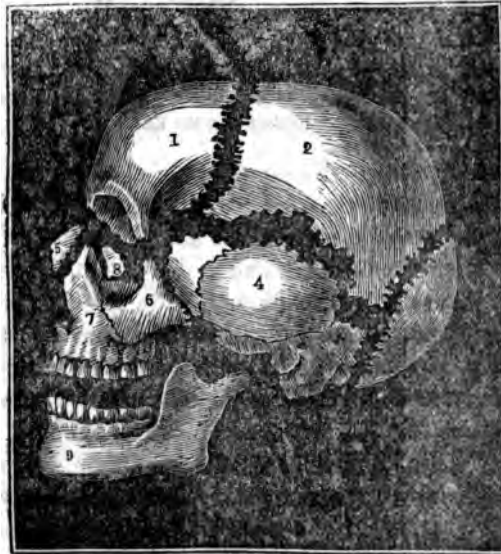


F. the Frontal Bone. P. Parietal Bone. T. Temporal Bone. O. Occipital. S. Sphenoid. C. Cheek-bone. J. Upper Jaw Bone. L. J. Lower Jaw Bone. N. Nasal Bone. L. Lacrymal Bone. E. Hole leading into the Ear.

The cranium or brain case is composed of eight bones, which are mostly of a flattened form, convex externally, and concave internally. The frontal bone forms the forehead, and the roofs of the orbits; the occipital bone forms the back and under part of the head, and in this bone is the large hole through which the spinal marrow passes down from the brain. The two parietal bones meet in the middle above, and form the upper and lateral parts of the head; in the centre of each is a protuberance giving the greatest breadth to the head, rather further back than its middle. The temporal bones are named from the Latin word *tempus*, signifying time, because on the hair covering them, the traces of time are first manifested. They are placed one on each side, occupying the inferior lateral parts of the cranium, and extending into its base. In each is seen the funnel-shaped opening which admits the waves of the air to the drum of the ear, called the external auditory canal, to the edges of which the external ear is appended. The hard part of each, extending into the base of the cranium, contains the proper organ of

hearing. The two remaining bones are placed at the base of the cranium, and belong equally to it and to the face. The ethmoid or sieve-like bone is so named on account of its upper plate being perforated with forty or fifty holes, through which the twigs of the olfactory nerves pass into the nose. The sphenoid, or wedge-like bone, is named, not from any similarity to a wedge in shape, but from its being wedged in among so many other bones; for it is united to the other seven bones of the cranium, and to five of the face.

The vault of the cranium is smooth and regular where it forms a roof for the protection of the brain; the floor of it is divided into six pits or deep hollows, for containing the different lobes of the brain. Numerous holes exist in the base of the cranium, for the entrance of the nourishing arteries of the brain, for the exit of its veins, and for the exit of the numerous nerves which are to connect the brain with the organs of the senses, and with the other parts of the body. The following figure represents the sutures of the cranium separated, after Beuchene, of Paris. I have a beautiful preparation of this kind in my Anatomical Museum.



Side view of the Cranium. 1. Frontal Bone. 2. Parietal. 3. Occipital. 4. Temporal. 5. Nasal. 6. Malar. 7. Superior Maxillary. 8. Unguis. 9. Inferior Maxillary.

The shape of the head, as well as its size, varies greatly in dif-

ferent individuals. There are also national peculiarities in the form of the head, constituting a well-marked national feature. Thus the Caucasian race, to whom we belong, is distinguished by the beautiful oval form of the head. To this race the most civilized nations belong, and those which have ruled over the others. The Mongolian race, which inhabits China and Japan, is known by its prominent cheek-bones, flat face, narrow and oblique eyes, straight and black hair, thin beard, and olive complexion.

The negro race has a compressed skull and a flattened nose, a prominent mouth, and thick lips; thus bearing some resemblance in features to the monkey tribe. The North American Indian has a very singular shaped head; it being high from the ear upward, and short from the front to the back. The forehead is not as largely developed as in the Caucasian. The head of the Hindoo is much smaller than that of the European, while that of the New-Hollander is but little superior to that of the ourang outang, who roams the same forests with himself. The New Zealanders have heads nearly as large as the European; but the forehead is low, and the great preponderance of size is in the back part of the head.

The heads of the ancient Egyptians, as appears from an examination of mummies, closely resembled in shape and size those of modern Europeans. Some of our North American Indians are in the habit of flattening their heads by binding a piece of board on the fore as well as back part of the head, in infancy. From this custom, one tribe among the Rocky Mountains has received the name of Flat Head Indians. The Choctaw tribe were formerly in the habit of flattening their heads in the same way; but for some years past they have discontinued the practice. The heads of the different European nations differ somewhat from each other; but a common type characterizes them all.

Not only the size, but the *texture* of skulls among different nations varies. The grain of the New Holland skulls is extremely rough and coarse; that of the Hindoos, fine, smooth, and compact, more closely resembling ivory. The Swiss skulls are open and soft in the grain, while the Greek are closer and finer. It has been suggested that there may possibly be a corresponding quality of brain in the individuals, which may influence the mental, and consequently the national character. This difference is generally attributed to the effects of temperament. In my Anatomical Museum I have the models of twenty-five different heads of races, each hav-

ing a different peculiar national distinction and character. A strong inference in favor of phrenology may be drawn from this fact.

The bones of the cranium increase in extent, thickness, and weight, from the commencement till the termination of their development in adult age; but after this time, and till old age, they always diminish in these three relations. In advanced life we often find them reduced to a mere shell, and perhaps perforated in some places. They thus become much lighter than in middle life. Meckel found the skull of a female, seventy years of age, weigh but fourteen ounces, while that of a girl, twenty years of age, weighed twenty-four ounces. In the early periods of life, the whole form of the head is much rounder than at an advanced age; owing, perhaps, to the small development of the face, while the skull develops in every direction.

The size of the cavity formed by the bones of the skull is always proportional to the size of the organs it lodges and protects. The shape and size of the cranium depend on the brain, and not of the brain on the cranium. The soft parts model and adapt to themselves the hard, and not the hard the soft. The brain is formed before the case which contains it, and it is not till after several years that the bones of the cranium become perfectly consolidated. In a child of ten years of age, afflicted with dropsy in the head from infancy, and which was exhibited a year or two since in this city as a great curiosity, although the head measured thirty-two inches in circumference above the ears, yet nearly the whole surface was protected by a bony covering.*

The face consists of fourteen bones, six pair and two single ones. The two upper jaw-bones form the principal part of the face. They meet in the middle line, forming the arch in which the upper row of teeth are set, and extend backwards, forming the principal part of the roof of the mouth. A process runs up from each, separating the cavity of the nose from that of the orbit. In order that the face may be light, the body of the maxillary bone is not solid, but excavated, the cavity communicating with the nose, as will be seen in the description of that organ. The roof of the mouth is completed by the two palate bones. The firm part of the nose, from its roof to its bridge, is formed of two small pieces, meeting in the middle, called the nasal bones. These are liable to be broken or knocked in by a blow, an injury which occasions great disfigurement. The opening of the nose in front is seen in the skull to be

* Lee.

of an oval figure, bounded by the two nasal and the two upper jaw-bones, called upper and lower maxillary bones. Bounding the lower and outer parts of the orbits are the two malar or cheek-bones, making the prominences at the sides of the face, which are so marked in the races of Celtic origin. At the inner sides of the orbits are two little bones of the size and shape of the finger nail, called the lachrymal bones, because they form the chief part of the canal through which the tears find their way into the nose. Forming the partition of the nose, is a bone resembling the ploughshare in shape, whence its Latin name of *vomer*; and in each side of the nose is a spongy bone, for the purpose of extending the olfactory surface. Finally, the lower jaw is a single bone, its dental arch equalling in size that formed by the two upper jaw-bones, and containing as many teeth. The fore part of the bone is the chin, extending back from which, and gradually separating from each other, are the sides, which terminate at the angles; and from the angles the branches rise nearly perpendicularly upwards to be jointed to the sockets in the temporal bones, called condyles.

Though composed of so many pieces, the whole head moves as one mass on the top of the spine; and the only motion that takes place between its parts, is that of opening and closing the mouth. This is done by the lower jaw dropping and being again lifted, while the upper jaw remains unmoved. This holds good in all beasts and birds; it is only when we descend to the reptiles and fishes that we find both jaws moving, as in the crocodile and the shark.

The orbits are two cavities placed in the face for containing the eyes. Each orbit is of a conical figure, the apex being behind, where the optic nerve enters it, and the base being in front; and it is much larger than is necessary for the size of the eye alone, this delicate organ being cushioned on a quantity of soft fat, in order that it may move with the greatest ease in every direction. The inner walls of the orbits are parallel, while their outer walls diverge widely from one another, to give the eyes the advantage of as wide a range as possible.

The lower extremities consist each of thirty bones. The *femur* or thigh contains a single bone, the largest in the whole body. It has a long shaft, from which a neck goes off above, at an oblique angle, surmounted by a smooth globular head, covered with cartilage, which is received into the socket that has been described as existing on the pelvis. Where the neck of the bone joins the shaft,

are two prominences which serve as levers for the attachment of strong muscles. The lower ends of the thigh-bones are large, and rest on the heads of the *tibia* and *fibula* shin-bones. Their lower ends are much nearer one another than their upper ends, thus bringing the points of support underneath the weight of the body. The bones of the leg are two. The *tibia*, or shin, is the inner and the larger, placed perpendicularly under the body; it has a broad end above to articulate with the thigh-bone, and a smaller one below to unite with the foot in the ankle-joint. One of its ridges is felt under the skin the whole way down, and is the part usually known as the shin. The outer bone, called the *fibula*, passes from the upper end of the shin-bone to the lower; it is connected with the ankle-joint, but forms no part of the knee-joint; it has no connexion with the thigh-bone, and therefore supports no part of the weight of the body. It serves to increase the breadth of the leg, without adding much to the weight, and is connected in its whole length to the shin-bone by a strong membrane or interosseous ligament, which serves to give attachment to muscles as well as if it had been bone, with the advantage of being much lighter. The lower ends of these two bones make the projections which are called the inner and outer ankles, or *malleolus*.

Intermediate to the thigh and leg is the kneecap, *patella*, a bone which corresponds to the elbow in the upper extremity. It glides on the smooth anterior part of the thigh-bone, is attached to the shin-bone by a strong ligament, and has the powerful extensor muscles of the leg inserted in it. It increases the power of these muscles, by throwing their attachment forward, and therefore further from the centre of motion of the leg, thus conferring on them the advantage of a lever power.

The foot consists of twenty-six bones. Seven of these form the *tarsus*, or solid part of the foot, to which no English word corresponds; five compose the instep, or *metatarsus*, and the remaining fourteen are the joints of the toes. One of the bones of the *tarsus* is shaped above like a pulley, and is received between the projections of the two bones of the leg forming the two ankles, so that by its motion the foot is bent up at right angles to the leg, or pointed with the toes downward. The bone of the heel projects nearly an inch and a half backwards, giving a strong lever for the insertion of the powerful muscles which form the calf of the leg. The next bone is in front of the pulley-like bone, and in some persons is very movable, admitting of much lateral motion across

the middle of the foot. Three wedge-shaped and one cuboid bone in front of these complete the tarsus, and support the bones of the instep. The five bones of the metatarsus are each about two inches and a half long; they are attached posteriorly to the solid part of the foot, and anteriorly they support the toes. Their anterior ends rest upon the ground in standing; so that the foot presents an arch, the end of the heel bone behind, and the ends of the metatarsal bones in front, being the abutments, while the pulley-like bone is the keystone on which the weight of the body rests. This arch is not, however, firm or rigid, but yields a little when leant on; and to prevent its yielding too much, is strengthened below with strong ligaments, passing like a bowstring from behind forwards. The degree of hollowness is very different in different persons; and those in whom it is most developed are always most active, and the best pedestrians. The foot is also arched from side to side; and in the hollow thus gained, the blood-vessels, nerves, and tendons going to the toes, lie secure from injury by pressure. The metatarsal bone of the great toe is much stronger than that of any of the rest. To this toe there are only two movable pieces, much larger than those of the other toes. Each of the smaller toes has three pieces, similar to the pieces of the fingers, but much smaller, as they are not intended for laying hold with. The last piece is enlarged at the point, for supporting the nail on its upper, and the pulpy extremity of the toe on its lower surface.

The upper extremities have a strong general resemblance to the lower, the shoulder corresponding to the pelvis, the arm to the thigh, the forearm to the leg, and the hand to the foot; but the differences between them are also very striking. The lower limbs are formed for progression, and for supporting the weight of the rest of the body; the upper are formed for prehension, much less strong, but much more movable. The shoulder is not fixed immovably to the trunk; the shoulder-blade, formed by the clavicle and scapula, glides on the back of the ribs, and is joined firmly to the outer end of the collar-bone; and the inner end of this is connected to a socket on the upper corner of the breast-bone, which permits great freedom of motion, but forms a centre, round which the shoulder plays, being capable of being raised or depressed, carried forwards or backwards. The collar-bone is slender, curved like a long italic *f*; and as all shocks produced by falls on any part of the upper extremity are transmitted through it, it is one of the bones the most frequently broken. The scapula or shoulder-

blade is triangular, with one angle directed downward, one upward, and one outward, and it covers the ribs from the second to the seventh. It is not, however, attached to the ribs, but is separated from them by a cushion of muscle on which it glides. At its external angle there is a socket for the bone of the arm so shallow that this bone is not laid into it, but merely against it, which is one reason of the frequency of dislocations of the shoulder-joint. The bone of the arm (*humerus*) is single, attached above to the shoulder-blade, and below to the bones of the forearm, radius and ulna, and forms at the elbow a perfect hinge-joint. It has a large round head, which is united by a ball and socket-joint with the shoulder, capable of motion in every direction, and by a hinge-joint with the forearm, capable of flexion and extension. It has two projections externally and internally just above the elbow, which give the breadth to this part of the limb, and to which the muscles of the forearm are attached. The bones of the forearm are two, the *radius* and *ulna*, the former being on the outer side, and the latter on the inner. The ulna is connected chiefly with the elbow-joint, and the radius chiefly with the wrist; so that when a fall is received on the hand, the force is transmitted through the radius much more than through the ulna, and hence the radius is broken much more frequently than any other bone in the body. The ulna is articulated very firmly to the humerus or arm bone, and moves on it in flexion and extension; it can be bent up very close to it, and can be extended very nearly in a straight line with it. The radius is very slightly connected with the arm bone, and has a round head received into a cavity in the outside of the ulna while at its lower end it has a cavity in its inner side, which roll round the small lower end of the ulna. The effect of this arrangement is, that the ulna has always the same face directed forward while the radius can roll round the ulna, so that its edge, or even its back, can be turned forward, carrying the hand along with it. This motion is commonly said to take place in the wrist, but in reality the wrist has nothing to do with it. It is called pronation and supination; the hand is said to be prone when its back, and supine when its palm is turned forward. It is in this motion that the greatest difference is observed between the forearm and the leg; had any such motion been permitted in the leg, it would have produced instability. The two bones are connected in their whole length by a strong membrane, which gives origin to muscles, while it does not interfere with the rolling motion. The two extremities

of the ulna are readily felt, both the upper and the lower, and afforded a very ready standard of measurement, called the cubit, from the old Latin name of the bone, *cubitus*.

The hand consists of twenty-seven bones, and is divided into three parts, analogous to those of the foot. The solid part entering into the wrist joint is properly called the wrist; then five long bones make the palm, and fourteen movable pieces superadded, complete the fingers and thumb. It differs from the foot, in its being intended not for support, but for prehension, and all its parts are adapted to this end. Eight small bones are pretty firmly united to form the wrist, presenting a ball superiorly to enter the cavity in the lower end of the radius; fitted inferiorly to support the bones of the palm; arched behind to give it strength, and concave in front to permit the blood-vessels, nerves, and sinews, to run to the fingers, without being subjected to undue pressure. In the palm we see the great difference between the hand and the foot. In the latter all the bones of the instep are in one line, immovable, and serving only to rest on. In the former, four of the bones of the palm are placed side by side, to form the hollow of the hand, and support the fingers; while another, supporting the thumb, is very movable, being capable of being brought opposite the others, so as to grasp firmly anything between them and it. The pieces of the fingers are considerably larger than those of the toes, but are formed on a similar model. The fingers have each three pieces, the thumb only two. The last piece of each is expanded at the end, to support the nail on the back, and on the front the delicate pulp where the nerves ramify, in which the nicest sense of touch exists.

The size of the skeleton varies very much, varying from thirty-five inches to upwards of eight feet. The gigantic skeleton preserved in the Museum of the College of Surgeons in London measures eight feet two inches. What is called the middle size in man, is about five feet four, in woman about five feet.

The formation and growth of bones is an exceedingly interesting subject, but one that can well be studied in the museum, where there are preserved abundant specimens of young children at every different period of foetal life. In the foetus cartilage serves as a substitute for bone at first: and about the sixth week after conception, earthy matter begins to be deposited in it. In the flat bones, it is first deposited in the centre, and extends in lines radiating to the circumference, forming a delicate net-work like a bit of lace,

and layer is superadded upon layer, until the necessary degree of thickness is obtained. In the round bones, ossification proceeds from the centre to the circumference. In the long bones, ossification commences at the middle of the shaft, and extends outward gradually till near the ends, where it stops. At a period soon after birth, the ends of the long bones begin to ossify separately, at their centre, in the same way that the short bones do, and they continue separated from the shafts of the bones by a layer of cartilage, till the 15th, 16th, or even 18th year. Hence children should on no account be rudely pulled about, or twisted about the limbs, as the ends of the bones are apt to be twisted off, producing incurable lameness.

The most common affection for which we have to treat bones, is their fracture. Most of the bones when broken unite in three weeks, if properly kept at rest, but the thigh-bone is never fit for walking upon in less than six.

The following list exhibits the number of bones in the several regions of the body.

The Spine contains	24
Pelvis, ...	5
Breast-bone, ...	1
Ribs, ...	24
Arms, ...	64
Legs, ...	60
Head, ...	22
Total, ...	200*

RECAPITULATION.

BONES OF THE HEAD.

Frontal Bone. Situated in the anterior part of the skull, forming the forehead and upper part of the orbits.

Parietal Bones. Situated one on each side of the superior part of the cranium.

Occipital Bone. Situated in the posterior part of the cranium.

* *Sphenoid Bone.* Situated in the middle of the basis of the cranium, extending underneath from one temple across to the other.

Temporal Bones. Situated at the sides and inferior part of the cranium.

* Douglas.

Ethmoid Bone. Situated in the anterior part of the basis of the cranium, above the root of the nose and between the orbits.

BONES OF THE FACE

The bones of the face are fourteen in number, and are divided into those of the upper and under jaw. The upper jaw is formed of thirteen bones, viz. two superior maxillary, two nasal, two palatine, two jugular or malar, two inferior spongy, two lachrymal, and the vomer, which are united to the cranium, and with one another, by harmony. The under jaw consists of one bone.

Superior Maxillary Bones. Situated in the anterior and middle part of the face.

Jugular or Malar Bones. Situated at the sides of the face.

Ossa Nasi, or Bones of the Nose. Situated in the superior and middle part of the nose.

Lachrymal Bones. Situated in the internal angle of the orbit.

Inferior Spongy Bones. Situated in the side and lower part of the nostrils.

Palatine Bones. Situated in the posterior part of the nose, from which they ascend laterally to the orbits.

Vomer. Situated in the middle of the cavity of the nostrils, which it divides into two parts.

Lower Jaw Bone. Situated in the inferior and anterior part of the face.

Os Hyoides. Situated in the fauces, between the basis of the tongue and larynx.

BONES OF THE TRUNK.

The trunk of the skeleton is divided into the spine, chest, loins, and pelvis.

Spine. A long column, or pillar, which extends in the posterior part of the trunk from the occipital bone to the os sacrum. Composed of 24 bones called vertebræ, viz. 7 of the neck, 12 of the back, and 5 of the loins.

BONES OF THE CHEST, OR THORAX.

The thorax is composed of twelve dorsal vertebræ, twenty-four ribs, and the sternum.

Sternum. Situated in the anterior part of the thorax, between the true ribs.

BONES OF THE PELVIS.

Ossa Innominata. Situated at the sides of the pelvis. Figure, irregular. Each bone is divided into three parts, viz. ilium the uppermost, ischium the lowest, and pubis the anterior. Eminences—The crista of the ilium, from which the oblique and transverse muscles of the abdomen arise—at its posterior part are two spinous processes, which give adhesion to ligaments—at its anterior part are also two spinous processes, the superior gives adhesion to the sartorius, tensor vaginæ femoris, and the ligament of the thigh; the inferior anterior spinous process, about an inch from the former, has arising from it the rectus femoris. The external surface of the iliac portion is covered by the glutæi muscles; the internal by the internal iliac. Upon the internal surface there is a line even with the pubis; this is called *linea innominata*, or rim of the pelvis; it divides the cavity of the abdomen from the pelvis. Upon the ischiatic portion or ischium are the tuberosity of the ischium, upon which we sit; the spinous process of the ischium, which projects backwards, and gives adhesion to the uppermost sacro-sciatic ligament; the ramus ischii, which joins the pubis. Upon the pubic portion, or pubis, are the body, near the socket, the angles and arches of the pubis. Cavities—A notch between the anterior spines of the ilium; an anterior and posterior ischiatic notch; the acetabulum, which receives the head of the os femoris, and the foramen thyroideum, or ovale. Each os innominatum is connected with its fellow anteriorly by symphysis, with the sacrum posteriorly by strong cartilages and ligaments, and with the head of the thigh-bone by enarthrosis. Use—To form the pelvis; to retain the gravid uterus in its situation, and to constitute the acetabulum for the thighs.

Os Sacrum. Situated at the posterior part of the pelvis.

Os Coccygis. Situated at the apex of the sacrum.

BONES OF THE SUPERIOR EXTREMITIES.

The bones of the upper extremities are, on each side, the clavicle, scapula, humerus, radius, ulna, bones of the carpus, metacarpus, and fingers.

Clavicle. Situated obliquely in the upper and lateral parts of the thorax

Scapula. Situated in the upper and lateral parts of the back.

Os Humeri. Situated between the scapula and fore-arm.

Cubit, or Ulna. Situated in the inside of the fore-arm, towards the little finger.

Radius. Situated in the external side of the fore-arm, towards the thumb.

Carpus or Wrist. Composed of eight bones, which lie close to each other in a double row. Situated between the fore-arm and metacarpus. Divided into two rows, superior and inferior. In the superior row are (from the thumb to the little finger) os scaphoides, or naviculare; os lunare; os cuneiforme; and os orbiculare, or sub-rotundum. In the lower, os trapezium; os trapezoides; os magnum, and os unciforme.

Metacarpus. Situated between the carpus and fingers. Composed of five longitudinal bones; one of the thumb, and four metacarpal bones of the fingers. Use—To form the middle part of the hand.

Fingers. Situated at the inferior extremity of the metacarpus. Composed of a thumb and four fingers. The thumb has two bones, and each finger three, which are called phalanges. Use—To form the fingers, which are the instruments of touch, defence, and labor.

BONES OF THE INFERIOR EXTREMITIES.

The bones of the inferior extremity are, the femur, patella, tibia, fibula, the bones of the tarsus, metatarsus, and toes.

Femur. Situated between the pelvis and tibia.

Tibia. Situated in the inside of the leg, between the femur and tarsus.

Fibula. Situated in the outer part of the leg, by the side of the tibia.

Patella, or Knee-pan. Situated in the sinus between the condyles of the femur, and above the tibia.

Tarsus. Situated between the leg and metatarsus. Composed of seven bones, placed in a double row.

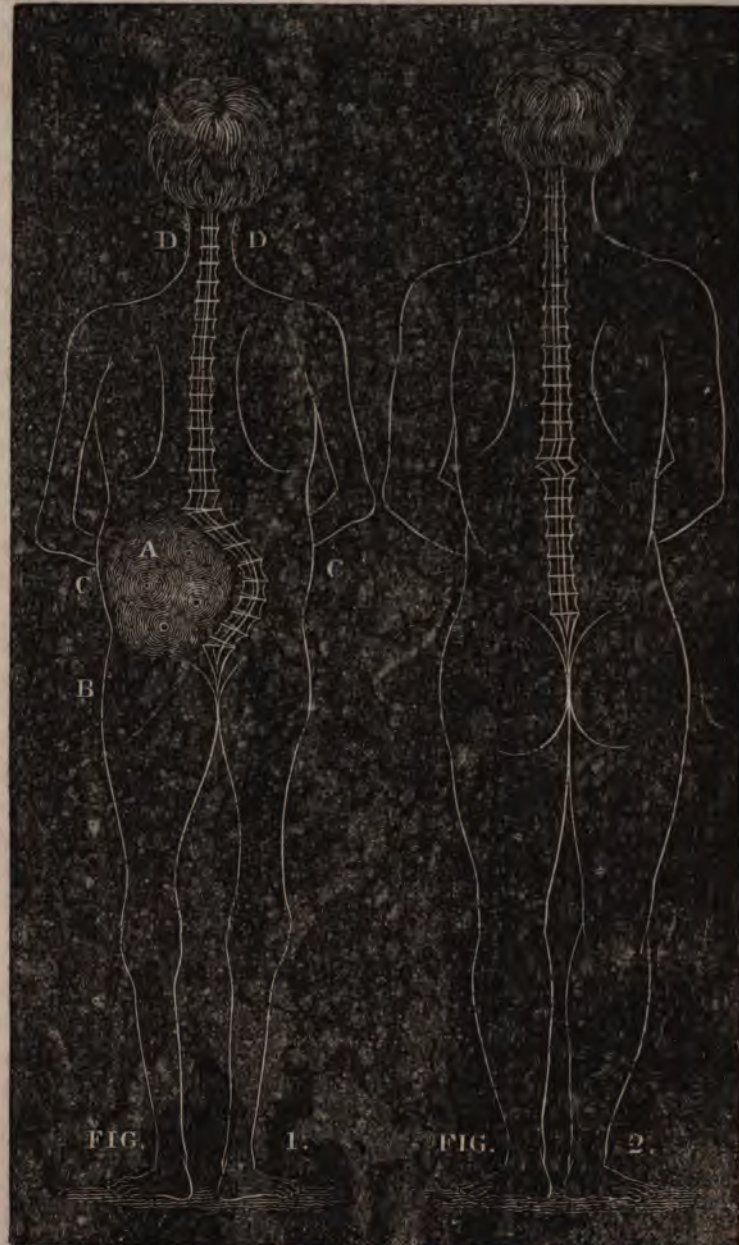
Metatarsus. Situated between the tarsus and toes. Composed of five longitudinal bones.

Toes. The great toe is composed of two small bones; each of the other toes, of three small bones, called phalanges.

PERIOSTEUM.

Definition. A membrane which invests the external and internal surface of all the bones except the crowns of the teeth. **Names.**—Pericranium on the cranium; periorbita on the orbits; perichondrium, when it covers cartilages; and peridesmium, when it covers ligaments. Substance fibrous, furnished with arteries, veins, nerves, and absorbent vessels. Use—To distribute the vessels on the external and internal surface of bones.

Bones are subject to disease, as the rickets, tumors, necrosis, curvatures, etc. The following figures, 1 and 2, illustrate a deformity of the spine by lumbar abscess, A.



[Plate from Dr. Sherwood.]

Children at school, in consequence of sitting long in a bent position, are very liable to a curvature or bending of the spine. The remedy consists in avoiding the causes—sitting in an erect position, exercising much in the open air, living on a light and principally vegetable diet, as bread and milk; bathing daily with cold water, keeping the bowels regular, and wearing a stimulating plaster on the spine, and avoid the use of mercury.

The following figure represents a contrivance to lessen the pressure or weight of the upper part of the body on the diseased spine.



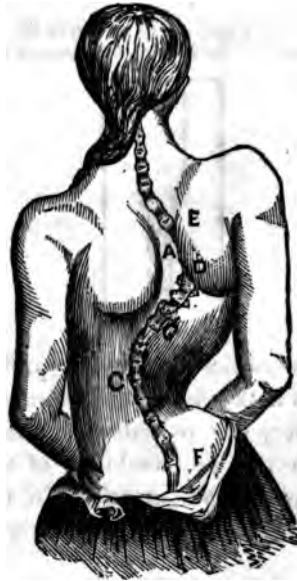
Says Dr. Lee, in his treatise on physiology, "How preposterous, unnatural, and ruinous is the practice of confining delicate females for hours together every day to sedentary employment, the sure consequence of which will be, weakness of the body generally, and of the back in particular, especially if the seat be a bench which has no back, or even a narrow chair with a perpendicular back.

"The effect of such a practice is, that in consequence of the fatigue induced by such a posture, the spine gives way in some part and bends, and in a little time the curvature becomes permanent. And often when a bend has taken place in one direction, there immediately follows an opposite bend above or below, to keep the centre of gravity of the body always directly over the base; the curve accordingly thus becomes double, like an italic *f*, and the distortion is rendered complete.

"The means employed to remedy this affection almost invariably make it worse. In the first place, strong, stiff stays are put on, to support the back, as it is said; and so they do, perhaps, while they are on; but as they supersede the action of the muscles, placed there by nature as the supports, they cause these to lose their strength; and when the stays are withdrawn, the muscles are found too weak to support the body. Other mechanical expedients may now be employed, the back may be forcibly stretched by pulleys,

or the patient may be kept all day and night lying on an inclined plane. The victim of fashion may next, perhaps, be placed under the charge of a regular *spine doctor*, who, by means of pulleys, screws, paddings, stays, and close confinement, destroys what little chance there still remains of a cure. A decline now sets in, and the sufferer sinks into an early grave."

The following figure represents a curvature of the spine.



CHAPTER IV.

THE JOINTS.

THE bones composing the skeleton are articulated to one another in three different ways. 1st. They are found dovetailed into one another, with the intervention of a very thin layer of cartilage, and are quite immovable. 2dly. They are connected by means of one or more layers of cartilage between them, and ligaments on their outsides, tying them together, and admitting of more or less motion. 3dly. They are united by means of cartilages, ligaments, and synovial membranes, forming the most perfect joints, such as are found in the extremities.

The unions of the bones of the cranium are called sutures, from the Latin word signifying to sew, because they seem as if stitched together, the fibres of the one bone forming prolongations which pass into the notches, or spaces left by the similar prolongations of the other, as is seen in the figure of the skull already given. Between these a thin layer of cartilage runs. These sutures run in determinate lines over the head, as seen in the drawing of the cranium, but in a work of this character it would be out of place to give a more detailed description of them.

The bones of the spine are united by thick layers of a peculiar cartilage mixed with ligaments, placed between them, admitting of but little motion between any pair of bones, but allowing considerable curvatures to take place in the whole length of the spine. Strong ligaments also pass down the spine in front and behind, binding its different pieces together. The different parts of the pelvis are united by means of cartilage, each bone having its articulating surface covered with cartilage, and these laid together, with or without the intervention of a third layer, and are bound firmly by ligaments passing over them. Such are the joints between the two haunch-bones, and between them and the ischium.

The joints of the extremities are of a more complicated nature. The ends of the bones entering into the joints are covered with cartilage, then the bones are tied together by ligaments, and in addition a membrane called synovial is spread over the ends of the bones and lines the ligaments, forming a shut bag, whose inner surfaces are everywhere in contact, and to obviate friction are moistened with a bland mucilaginous fluid called synovia. This fluid, which serves the purpose of oil to the joints, does not in reality contain any, yet it has very much the feeling of oil when rubbed between the fingers. When it increases too much in quantity, it produces dropsy of the joints.



A Finger-joint is represented. B. B. are the two bones. L. L. the two ligaments; the cartilages are seen covering the ends of the bones, and inside of this the synovial membrane is seen lining them and the ligaments. A space is represented between the bones merely for the sake of making it plainer; but in reality the surfaces are in contact.

The articulation of the lower jaw with the temporal bone is almost completely a hinge-joint. The upper end, or condyle of the jaw-bone, is covered with cartilage, and so is the socket; and the two bones are tied together by side ligaments. Besides, there is a movable cartilage in the joint, which accompanies the condyle of the jaw in its motion. Notwithstanding all these appliances, the jaw is sometimes dislocated, slipping forward off the eminence upon which it gets when the mouth is opened. When this accident takes place, which generally happens from a violent yawn, the patient is left with his mouth wide open, and has not the power of closing it, presenting a very ludicrous figure, though his situation is to himself sufficiently uncomfortable. After this accident has happened, it is exceedingly liable to be reproduced, in consequence of the torn ligaments never properly uniting.

The shoulder-joint is of all others the most frequently dislocated. This results partly from its form, and partly from its being more exposed to violence, since every fall, whether upon the shoulder, elbow, or hand, has a tendency to displace it. The cavity on the shoulder-blade is so small and shallow, that the round head of the arm-bone is not laid in it but on it; its capsular ligament is strong but loose, so that the bone depends for being retained in its place upon the muscles which surround it; and if these are overcome, or taken by surprise, particularly when the arm is raised above the head, the head of the bone is dislocated down into the armpit. It is in general replaced without much difficulty, but is exceedingly liable to be thrown out again. I recollect one man, says Douglas, who fell into fits occasionally, whose shoulder-joint I saw dislocated and assisted to reduce three times, on three successive days.

The elbow-joint is more complex than the shoulder-joint. It is double in its motions, admitting of the flexion and extension of the forearm on the arm, and the rolling of the head of the radius. For the first motion it has two strong lateral ligaments, which render it a hinge-joint, and the neck of the radius is confined to the side of the ulna by a collar in which it rolls. A synovial membrane covers the ends of the bones, and lines the different ligaments. It may be dislocated in many directions. Both bones of the forearm are most commonly thrown backward; then the arm is nearly straight, and cannot be bent. Sometimes the forearm is thrown sideways, either outward or inward, and sometimes the radius is dislocated alone, either backwards or forwards. From its complexity, it is also subject to disease.

The wrist-joint is a hinge-joint, moving backwards and forwards, and also allowing the hand to be moved a little edgewise outwards or inwards. The lower end of the *radius* forms a socket in which the two uppermost bones of the wrist move, united so as to form an oblong ball. Two lateral ligaments confine the hand to the lower ends of the radius and ulna, and the whole joint is lined by a synovial membrane. This joint is never dislocated, but it is liable to sprains, and to disease, producing occasionally the loss of the hand.

The bones in the hand are not subject to dislocations, except at the joint between the first and second pieces of the thumb—a seemingly trifling affair, but one which is extremely difficult to set to rights; so much so, that many of those who are the subjects of the accident continue to go with the point of the thumb bent back, all the rest of their days.

The only dislocation that takes place in the spine is that between the first and second vertebræ of the neck, in consequence of destruction of a ligament which keeps them in their places. When this happens, the weight of the head makes it fall forward, carrying the first vertebra with it, and the spinal marrow is so nipt between it and the second, that the sufferer dies as surely and as instantaneously as if his neck were severed by the axe of the executioner.

The hip-joint consists of a deep socket, formed by the *ilium* above, *ischium* lower, and *pubes* before, into which the round head of the *femur* or thigh-bone is set. The opposed surfaces are covered with cartilage, and are tied together by an internal ligament. A capsular ligament of great strength, attached round the edge of the socket and to the neck of the bone, fixes it in its place. The whole is lined by a synovial membrane. The joint is, notwithstanding its strength, subject to dislocations, principally on account of the long lever which the thigh-bone affords to any force acting upon it, so as to tear the head from its socket.

The knee is the most complicated joint in the whole body. The ends of the *femur* or thigh-bone and *tibia* are each covered with cartilage, and in contact, but neither of them is hollowed; so that the joint does not depend for its strength on its form, but on the number and strength of its ligaments. Two of these are placed externally and internally, as in all hinge-joints, and seven others are arranged in different positions within and without it. The kneecap (*patella*) is placed in front of it, and the whole is lined with a synovial membrane, which is the largest in the body: hence

the fever and constitutional disturbance that arise when this joint becomes inflamed. It lies very superficial, being covered only by the skin in the greatest part of its extent, and hence it is very easily wounded by a cut or prick from any sharp instrument. It is never dislocated, except by such a force as destroys it altogether.

The ankle is a hinge-joint, having one lateral ligament on its inner, and three on its outer side. The upper surface of the *astragalus*, as has been already said, is like the half of a broad pulley; it plays against the lower hollow end of the *tibia*, and is received between the two ankles, formed by it and the *fibula*. This part of the astragalus is narrower behind than in front, so that when the foot is at right angles to the leg, as when we stand on it, the broad part is between the ankles, and it is firmly fixed; but when the foot is extended, pointed downwards, the narrow part is brought between them, so as to admit of the toes being directed to either side. The ankle joint may be dislocated forwards or to either side. This never happens without one of the ankles being broken off; the ligaments being so strong that the bone will break rather than they should give way. The dislocation of the ankle can scarcely take place without a wound co-existing. I may here mention what is meant by a *compound*, and what by a *simple* dislocation. A simple dislocation is one where the bones are displaced, but the skin is unbroken; a compound one is not more serious, in so far as the bones are concerned, but is accompanied with a wound leading into the joint. In the same way, a simple fracture is where a bone is broken, without a wound; a compound one is where there is a wound communicating with the broken surfaces. The joints across the foot are numerous. There is one joint across the middle of the *tarsus* or solid part of the foot, which in some persons admits of much lateral motion, and in such feet, is liable to be sprained. Another joint runs across between the bones of the tarsus and those of the instep. The joints of the toes require nothing particular to be said of them, only that in persons who live very freely and drink much wine, they are apt to become affected with gout; and in elderly people the joint at the ball of the great toe is liable to be drawn so as to make a projection on the inner side of the foot, become exposed to pressure from the shoe, and produce corns.

The most common disease of joints is their inflammation. Sometimes this is acute, as after injuries or from rheumatism. The synovial bag becomes inflamed, and forms an inordinate quantity of

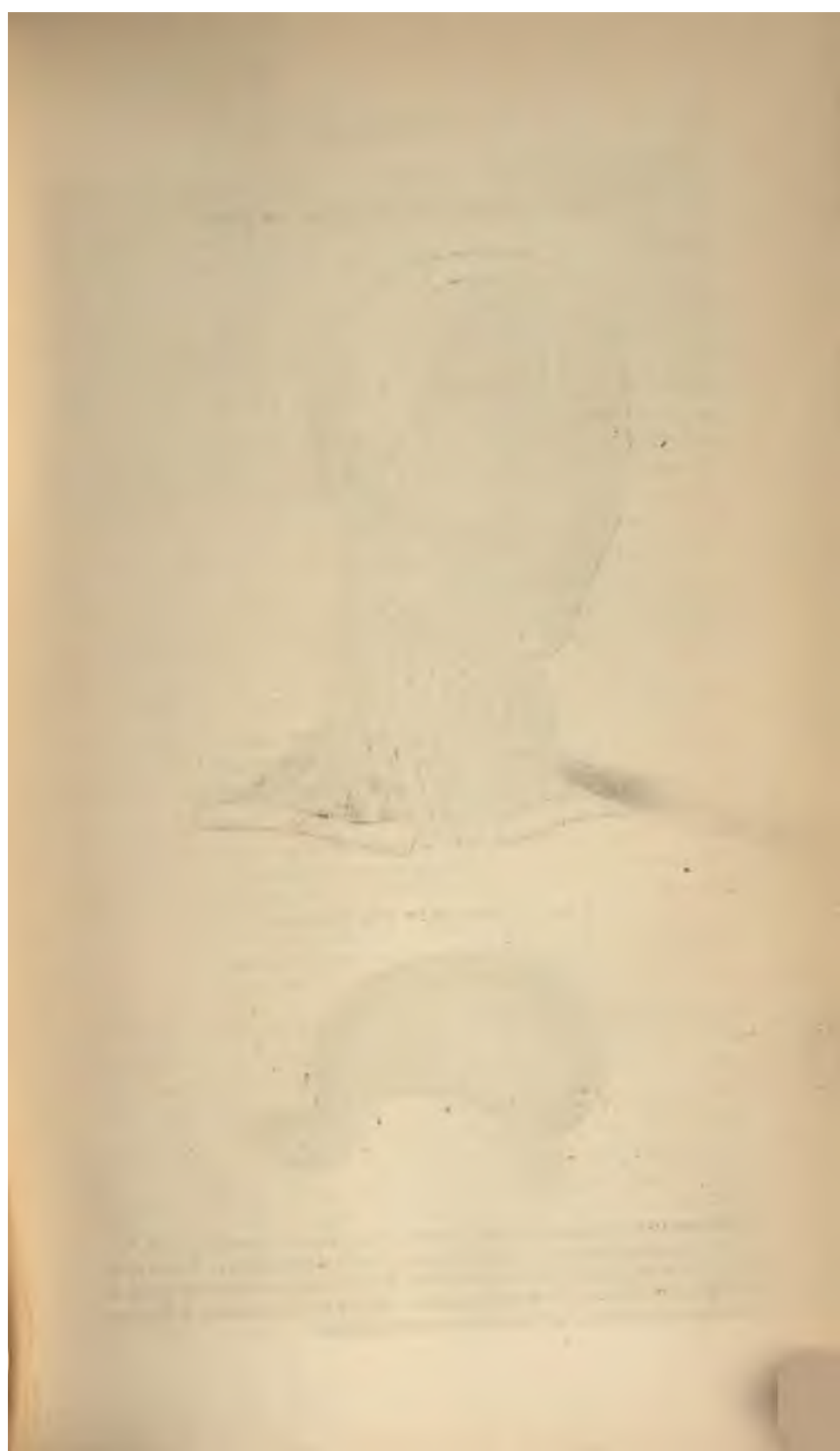


FIG. 5. MUSCLES OF THE HEAD AND NECK.



FIG. 6. MUSCLES OF THE STOMACH



Fibres are seen running in different directions to produce the "churning motion."

1. The œsophagus terminating in the stomach. 2 The cardiac orifice. 3. The pylorus. 4. The commencement of the duodenum. 5. The large curvature of the stomach. 6. The small curvature. 7. The large extremity. 8. The small extremity. 9. The longitudinal muscular fibres, 10. The circular muscular fibres.

fluid, which distends the joint enormously. It is accompanied with intense redness and acute pain, and requires fomentation and other treatment to reduce it. In scrofulous persons, the inflammation does not assume this acute form, but is low and long-continued; the synovial membrane forms purulent matter, instead of merely an increased quantity of its natural secretion; the matter gradually works its way to the surface, making one or two ulcerated openings, leading directly into the joint, and by and by the cartilages are destroyed, and if a probe be introduced, the ends of the bones are felt to be bare and rough. In this state the patient's general health suffers much; he becomes affected with shivering, profuse night sweats, and often purging, &c.

CHAPTER V.

THE MUSCLES.

Knowest thou the nature of the human frame,
 'That world of wonders, more than we can name?
 Say, has thy busy, curious eye survey'd
 The proofs of boundless wisdom there display'd,
 How ranged each *fibre* with amazing skill
 That every *muscle* may attend thy will;
 How every *tendon* acts upon its *bone*,
 And how the *nerves* receive their nicer tone;
 Convey the keen vibration of the sense;
 And give the wakeful mind intelligence,
 How some strong guard each *vital* part sustains,
 How flows the *purple liquid* through the *veins*!

In order that the bones when connected by their joints may be brought into motion, there must exist to each a moving power. The moving power resides in the muscles. Muscles are the masses of red flesh which are seen in cutting a piece of meat, arranged in determinate forms, and separated from one another by cellular membrane and fat. When examined chemically, they are found to consist almost wholly of a principle derived from the blood, which is called fibrin. They are of a red color, not from any inherent quality of the fibrin, for they can be washed almost white, but from the large quantity of blood which is constantly circulating through them. Indeed, a muscle requires blood to go to it to be able to act, and

when healthy blood is not sent to it, it loses its contractile power. Each muscle is composed of small bundles of fibres, connected together by fine cellular membrane, running parallel to each other, and enveloped in a common sheath. Every muscle has at least two attachments; the one which is most fixed is called its origin, the one which is most ordinarily moved, is its insertion. The action of a muscle consists in shortening itself so as to bring its insertion nearer to its origin. In so doing, its fibres assume a zig-zag form, and the whole muscle becomes thicker, as may be easily proved by grasping the arm when straight with the other hand, and then bending it, when the muscles on the inside of the arm will be felt swelling as they shorten themselves. Or, let the fingers be laid on the side of the cheek, and the jaws firmly closed, and then the strong muscles whose action it is to close the jaws, will be felt becoming hard under the finger. A muscle may have its origin converted into its insertion by having the latter fixed. For instance, the strong muscles which bring down the arms in striking, may be reversed in their action; if you catch a beam above your head, their insertion into the arms will now be fixed, and they will swing up the body, so as to enable you to grasp the beam with the feet.

Most muscles have a tendon or sinew at one end, sometimes at both, by which they are fixed to their points of attachment in the movable parts of the skeleton. The forms of the muscles are very various, but are principally the following:—1. A single-bellied muscle, small at each end, thick and round in the middle; the middle swelled part is called its belly. A tendon is represented at one end. Of this kind are most of the muscles of the limbs. (Fig.



Fig. 1.

2.) 2. A double-bellied muscle, when there are two bellies meeting and becoming inserted by one tendon. (Fig. 2.) 3. A strap-shaped



Fig. 2.

muscle when the fibres run parallel to one another, forming a thin strap, with or without a tendon. (Fig. 3.) 4. A fan-shaped muscle



Fig. 3.

broad and thin at its origin, narrow and thick at its tendinous ap-



Fig. 4.

section. (Fig. 4.) 5. A single penniform muscle, like a quill with the feathers stripped off one side, the quill part representing the tendon,



Fig. 5.

and the feathery part the oblique short muscular fibres. (Fig. 5) 6. A double penniform muscle, like the quill with both its rows of feathers.



Fig. 6.

The number of muscles in the body is upwards of four hundred, varying slightly in different individuals. They are arranged in four

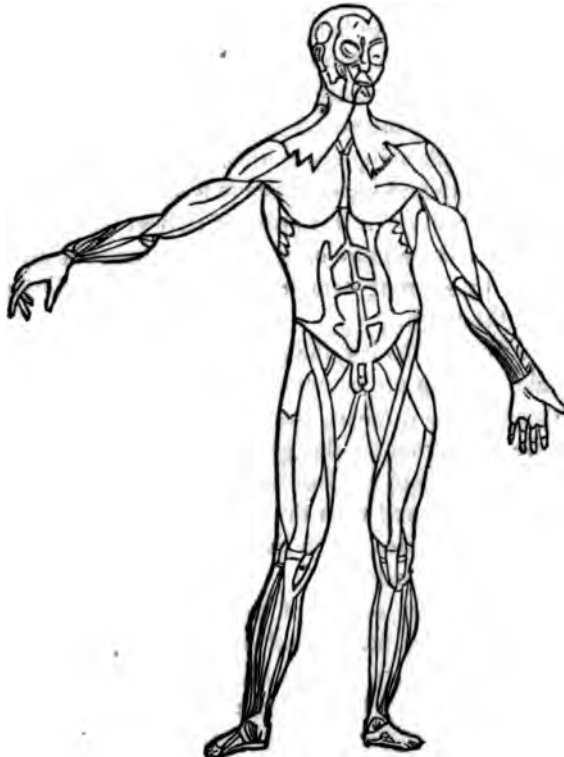


Fig. 7.

layers, of which the layer next the skin gives the form to the limbs, the eminences and depressions which it delights the painter to delineate. It would be an unprofitable task in a work like this to minutely describe the muscles, but I will shortly go over the principal of those which are seen in the accompanying plate (Fig. 7) of the superficial layer of muscles on the front of the body.

On the side of the neck is seen a broad thin muscle which throws the skin of the neck into wrinkles. Those which move the neck are concealed by this one. Further back is seen one which elevates the shoulder. On the top of the shoulder is seen the muscle which gives the rounded form to that part, and raises the arm. On the fore part of the chest is a broad triangular muscle which draws the arm across the chest. On the front of the arm is a large muscle which bends the elbow. Behind and internal to it is seen part of the large extensor of the elbow. Immediately below the elbow is seen a small muscle running obliquely across, which produces pronation, and throws the hand into the position which the right hand has in the drawing. Behind this are seen the extensors of the wrist and fingers, and on the fore part the flexors.

On the fore part of the belly are seen two strap-shaped muscles, divided by several cross bands, whose use is to bend the body forward. The two broad muscles covering the sides are of use to compress the belly in the action of expiration.

Crossing the thigh obliquely is a long strap-shaped muscle which bends both the hip and knee. Above it are seen portions of those which adduct, or draw it towards its fellow. Below the oblique muscle are seen three large ones which are inserted into the kneecap, and then by a strong tendon into the tibia, and which extend the leg upon the thigh.

Down the front of the leg, the tibia or shin-bone is seen bare. On its inner side are seen projecting the muscles of the calf, whose office it is to extend the foot, raising the heel and consequently the weight of the whole body from off the ground. On its outer side are seen the muscles which bend the foot upon the leg, and extend the toes. The skin is not removed from the hands and feet, because the tendons and small muscles which lie upon them are too minute to be shown on so small a scale.

Covering the upper region of the head, we have a thin tendon, with two fleshy bellies before, and two behind, the front ones seen in the figure. The hairy scalp is fixed to the outer surface of this tendon, while it is very loosely connected with the bone. Hence

when the anterior bellies contract, the scalp is drawn forwards, and when the posterior, it is carried back again. There are many individuals who have no power of moving the scalp in this way. This muscle is part of an apparatus which is very fully developed in many of the lower animals, for wrinkling the skin suddenly, to drive the flies off, as we see a horse do every now and then on a warm day. In them, a thin layer of this kind exists all over the body, but in man it is not needed, as the hands are at his disposal to do the same office more perfectly. Underneath the anterior bellies are two small muscles, not seen in the figure, running from the root of the nose outward under the eyebrow, and fixed to the skin there, which knit the eyebrows, drawing them together. On the side of the head are seen two thin muscles attached to the external ear, for drawing it upward and backward. These, like the muscles of the scalp, are rudimentary in the human species, being of use only in those animals whose ears serve them for fly-traps, and can be directed backward or forward to catch sounds coming from either quarter. Those men, however, who have much power over the scalp are generally able to shake the ears, although few of them are aware of it. I have seen Prof. Oliver practise this.

Passing around the eyelids is an orbicular muscle, which closes them. It will be observed in closing the eye that the upper eyelid only comes to meet the other, while the lower one moves horizontally towards the nose; having the effect of carrying any particles of dust which may have alighted on the eye towards the nose, whence they are washed out by the tears, or pass down into the nose. That part of the muscle which lies in the thickness of the lids is thin and pale, and is all that acts in the involuntary winking which takes place thousands of times during the day, in order to wipe the surface of the eyes; while the parts which lie on the forehead, the temple, and the cheek, are brought into action only when the eye is compressed strongly by an exertion of the will. In doing so, it wrinkles up the skin of the face, as is seen in a hearty laugh, when the eyes are half closed. The muscle which raises the upper eyelid is not here seen, for it lies deep within the orbit.

Another orbicular muscle closes the mouth, and is connected above to the partition of the nose, which it has the power of drawing down. It is the antagonist to all the other muscles which converge to the mouth, and according as they resist it in particular directions, it produces all manner of distortions of the mouth.

Lying on the side of the nose is a small triangular muscle which dilates the nostril. Its action will be felt if the nose be caught between the finger and thumb; it then acts almost irresistibly, expanding the nostril under the finger. A muscle is seen running down the side of the nose, connected to its wing and to the upper lip; it raises the upper lip, showing the teeth, and dilating at the same time the nostril. Lying deeper than this muscle, in the hollow above the eyetooth, is a small muscle running downward and outward, which lifts the angle of the mouth. Further out, coming from the prominence of the cheek-bone, are two long delicate muscles, inserted into the angle of the mouth, which distort it upwards and outwards, producing the depressed line which leads from the side of the nose to the angle of the mouth. Below, in the middle, is a muscle which depresses the under lip, and at the angle is a triangular one, attached like the preceding to the lower jaw, which draws down the angle of the mouth. All these are called the muscles of expression, because they produce all the different modifications of the features which express the feelings, as beautifully exhibited by Le Brun in his drawings illustrative of the passions.

It may be remarked here, that the muscles which express lively feeling and the gayer passions, such as the muscle of the scalp, the elevator of the eyelid, the elevators and dilators of the lips, do for the most part either raise or draw the parts from the middle line of the face; while those which manifest the sadder feelings and the darker passions, as the one which knits the brows, and the depressors of the lower lip and of the angles, either depress the parts, or draw them to the middle line. The constant and habitual exercise of either of these sets of muscles leaves corresponding permanent folds in the skin, which are indicative of the habitual feelings and passions of the individual.

On the side of the face we see two muscles which are not connected with the features, but with the action of mastication. One of them is of an oblong square form, lying on the ascending plate of the lower jaw; it closes the jaw forcibly, and may be felt swelling by the finger placed upon it when in action. Another is seen coming forwards, and closing the side of the mouth; it is the muscle which enables us to blow, as in playing on the flute, or in working with the blowpipe.

On the side of the neck, the superficial thin muscle, seen in figure 7, having been removed, a very large strong muscle is seen passing

from the breast-bone to the knob behind the ear. Its effect is to bend the face forward, turning it at the same time to the other side ; and when the muscles of the two sides act together, they simply bend the neck forward. Above and in front of this one, are seen three narrow strap-shaped muscles, which pull down the windpipe, as in singing the lower notes of the scale. Higher up, three small muscles are seen attached also to the windpipe, and in front to the jaw, which have the opposite effect of raising the wind-pipe, as in singing the higher notes, and in the act of swallowing.

There are some muscles connected with internal organs, which will be noticed in describing them, and giving a history of their functions. Let us now proceed to inquire into their physiology.

The property which muscles possess, and which distinguishes them from every other tissue in the body, is their contractility. This is quite different from elasticity ; it is the power of actively shortening themselves. This power is constantly in action ; for though we speak of the limbs being at rest, and the muscles relaxed, they are never really so ; they are constantly in such a state of tension as to balance their opponents, although not endeavoring to overcome them. Were this not the case, time would be lost in bringing the muscles into an active state when they are wanted to perform any action ; but as they are constituted, they are always tight, and ready to become strained the moment the stimulus of the will reaches them. Their irritability is a quality somewhat different from their contractility, expressing their capability of being excited to exertion by certain stimulants. If in the living body, or one newly dead, a muscle be pricked with a sharp instrument, it will immediately contract, as has been already stated in the commencement of this chapter. This tendency to show its contractility on the application of a stimulus is its irritability. This power of being excited becomes diminished by long exercise, and hence it is that after fatigue we feel scarcely able to crawl, and that over-driven cattle often fall down in the street ; and the capacity for renewed contractions is only recovered after sufficient rest and a supply of food has been taken.

There is one cause of death after which rigidity does not occur, namely, the shock of electricity. The bodies of persons killed by lightning never become stiff, the blood in them does not coagulate, and they run very rapidly into putrefaction. This is supposed to be owing to the nervous power having been exhausted by the shock,

it and electricity having been long supposed to be modifications of the same agent.

A very important remark with regard to the muscles is the sacrifice that we see of power to velocity and beauty of form. The muscles are generally inserted disadvantageously for mechanical power. For instance, the muscles which bend the elbow are inserted into the forearm about one inch beyond the elbow-joint, while the weight which is to be raised in the hand is nearly twelve times further off. Hence twelve times the power is expended in raising the weight from off the table, if the arm is laid flat along it, than if the muscles had been inserted directly into the hand. But what is lost in power is gained in velocity; the hand moves twelve times faster than the bone near the elbow, and hence the force with which we can strike a sudden blow. A man can cut or break a bar of iron with a stroke of an axe in his hand, while the whole weight of his body, if merely let down upon it, could not even drive a nail.

It has already been stated that the muscles are thrown into action through the medium of the nerves. Those which are connected by their nerves to the brain, are voluntary muscles; but there are many, such as the heart, and those for carrying on respiration and for keeping the bowels in motion, which are not dependent on the brain, and consequently not subject to the will; because if they had been so, and the individual were to forget to keep them going, life would be at once extinguished. There is, therefore, a distinction of muscles into voluntary and involuntary, but the prosecution of this subject belongs to the chapter upon the nerves.

The tendons of the muscles expand in many places into sheaths, with which all the limbs are covered. These are shining webs of a bluish color, which keep the muscles in their places, and prevent them from starting out. When tendons pass over bones, or through rings, they are generally surrounded by bags of the same nature as the synovial membrane of the joints, which have the effect of enabling them to glide easily, and without friction. Sometimes these bags enlarge, and form firm round swellings, particularly on the back of the wrist, where they are popularly called "weeping sinews." A popular cure is to wear a shilling or a piece of lead firmly tied over it; another plan is to have them punctured with a proper needle, when a quantity of jelly is squeezed out, and the cure is generally completed by pressure continued for a few days.

The muscles are the seat of that dull long-continued pain which

FIG. 3. A VIEW OF THE POSTERIOR
PART OF THE BODY.



The figures refer to various muscles, which
the student may learn and write down.

FIG. 4. A VIEW OF THE
EXTENSOR MUSCLES
OF THE FINGERS.



1 The common extensor
sending 2 2 2 2 tendons to
each finger. 3 The posterior
annular ligament.



is called chronic rheumatism. They are scarcely subject to any diseases, but occasionally they tear themselves, or rupture their tendons, by too violent and sudden exertion. The tendon which is most apt to suffer is that called the tendon of Achilles,* passing from the strong muscle of the calf down to the end of the heel bone; instant lameness is the consequence, which continues till the tendon becomes re-united. This is procured by keeping the foot in a bandage, or a boot made for the purpose, by which the heel is drawn up, so as to have the torn surfaces as near to one another as possible.

When a bone is broken, it must be obvious that the muscle will no longer produce the natural action which the bone served to direct, but will draw the piece that is broken off into some place where it ought not to be. When the thigh-bone is broken, for example, the strong muscles which pass along it from the pelvis to the leg, pull up the lower fragment, so that the limb becomes shortened. It is also liable to be distorted by the loose piece being pushed to one side or other. In treating fractures, we require, therefore, first to reduce them, or bring the broken ends into their proper places, and then we have to maintain them in apposition, by the application of an apparatus which will keep them immovable, till union has been obtained.

NAMES, ORIGIN, INSERTION, AND USES OF MUSCLES.

MUSCLES OF THE INTEGUMENTS OF THE CRANIUM.

Occipito-frontalis arises from the upper ridge of the occipital bone; its aponeurosis covers the upper part of the head. Inserted into the skin of the eyebrows and root of the nose. Use—To pull the skin of the head backwards, and to raise the eyebrows and skin of the forehead.

Corrugator supercilii arises above the root of the nose. Inserted into the inner part of the occipito-frontalis. Use—To wrinkle the eyebrows.

MUSCLES OF THE EYELIDS.

Orbicularis palpebrarum arises from around the outer edge of

* So called from the mythological fable, that when Thetis dipped her son Achilles in the river Styx, to render him invulnerable, she held him with her finger and thumb by this tendon. Hence this part escaped the contact of the stream, and it was here that he received his death wound.

the orbit. Inserted into the inner corner of the eyes. Use—To shut the eyes.

Levator palpebræ superioris, arises from the bottom of the orbit, near the optic foramen. Inserted into the cartilage of the tarsus of the upper eyelid. Use—To open the eye by raising the upper eyelid.

MUSCLES OF THE EYEBALL.

Rectus superior—rectus inferior—rectus internus—rectus externus, arises from around the optic foramen of the sphæmoid bone, at the bottom of the orbit. Inserted into the anterior part of the tunica sclerotica, opposite to each other. The action of the rectus superior is to raise the eye upwards—of the inferior, to pull it downwards—of the internus, to turn it to the nose—of the externus, to move it outwards.

Obliquus superior arises near the optic foramen and passes through a trochlea in the internal canthus of the eye, and is reflected to be inserted into the posterior part of the bulb, between the rectus and the entrance of the optic nerve. Use—To roll the eye, and turn the pupil downwards and outwards.

Obliquus inferior arises from the ductus nasalis, and is inserted opposite to the former. Use—To roll the eye.

MUSCLES OF THE NOSE AND MOUTH.

Levator labii superioris alaeque nasi arises from the nasal process of the superior maxillary bone. Inserted into the upper lip and ala of the nose. Use—It raises the upper lip and dilates the nostrils.

Levator labii superioris proprius arises from the upper jaw, under the orbit. Inserted into the middle of the lip. Use—To pull the upper lip directly upwards.

Levator anguli oris arises from the orbital foramen of the sup. max. bone. Inserted into the orbicularis, at the angle of the mouth. Use—To raise the corner of the mouth.

Zygomaticus major arises from the os jugale, near the zygomatic future and runs downwards. Inserted into the angle of the mouth, with the depressor of the lip. Use—To inflate the cheek and raise the angle of the mouth.

Zygomaticus minor arises above the zygomaticus major. Inserted into the angle of the mouth. Use—To raise the angle of the mouth outwards.

Buccinator arises from the sockets of the last molares, and the

coronoid process of the lower jaw. Inserted into the angle of the mouth, and is perforated by the duct of the parotid gland. Use—To contract the mouth, and draw the angle of it outwards and backwards.

Depressor anguli oris arises from the lower edge of the under jaw, near the chin. Inserted into the angle of the mouth. Use—To draw the corner of the mouth downwards.

Depressor labii inferioris arises from the inferior part of the lower jaw, next the chin. Inserted into the middle of the under lip. Use—To draw the under lip downwards and outwards.

Orbicularis oris; this muscle surrounds the lips, and is in a great measure formed by the buccinator, zygomatici, and others, which move the lip. Use—To shut the mouth by contracting the lips.

Depressor labii superioris alaeque nasi arises from the sockets of the upper incisor teeth. Inserted into the root of the ala nasi and upper lip. Use—To pull the ala nasi and upper lip down.

Constrictor nasi, arises from the root of one wing of the nose, and goes across the other. Use—To compress the wings of the nose.

Levator menti vel labii inferioris arises from the lower jaw, at the root of the incisors. Inserted into the skin in the centre of the chin. Use—To raise the under lip and skin of the chin.

MUSCLES OF THE EXTERNAL EAR.

Superior auris arises from the tendon of the occipito-frontalis, above the ear. Inserted into the root of the cartilaginous tube of the ear. Use—To draw the ear upwards, and make it tense.

Anterior auris arises near the back part of the zygoma. Inserted into the eminence behind the helix. Use—To raise the eminence forwards.

Posterior auris arises from the mastoid process by two, and sometimes three, fasciculi. Inserted into the septum that divides the scapha and concha. Use—To draw the ear back, and stretch the concha.

Helicis major arises from the upper, anterior, and acute part of the helix. Inserted into the cartilages of the helix, a little above the tragus. Use—To depress the upper part of the helix.

Helicis minor arises from the inferior and anterior part of the helix. Inserted into the crus of the helix. Use—To contract the fissure.

Tragicus arises from the outer and middle part of the concha,

near the tragus. Inserted into the upper part of the tragus. Use—to depress the concha, and pull the tragus a little outwards.

Antitragus arises from the root of the inner part of the helix. Inserted into the upper part of the antitragus. Use—To dilate the mouth of the concha.

Transversus auris arises from the upper part of the concha. Inserted into the inner part of the helix. Use—To draw these parts towards each other.

MUSCLES OF THE INTERNAL EAR.

Laxator tympani arises from the spinous process of the sphæmoid bone. Inserted into the long process of the malleus. Use—To draw the malleus obliquely forward towards its origin.

Tensor tympani arises from the cartilaginous extremity of the Eustachian tube. Inserted into the handle of the malleus. Use—To pull the malleus and membrane of the tympanum towards the petrous portion.

Stapedius arises from a little cavern in the petrous portion, near the cells of the mastoid process. Inserted into the posterior part of the head of the stapes. Use—To draw the stapes obliquely upwards towards the cavern.

MUSCLES OF THE LOWER JAW.

Temporalis arises from the lower part of the parietal bone and os frontis, squamous part of the temporal bone, back part of the os jugale, the temporal process of the sphæmoid bone, and the aponeurosis which covers it. Inserted into the coronoid process of the lower jaw, its fibres being bundled together and pressed into a small compass, so as to pass under the jugum, or zygoma. Use—To move the lower jaw upwards.

Masseter arises from the sup. max. bone, near the os jugale, and from the anterior part of the zygoma. Inserted into the angle of the lower jaw upwards to the basis of the coronoid process. Use—To raise and move the jaw a little forwards and backwards.

Pterygoideus internus arises from the internal pterygoid process of the sphæmoid bone. Inserted into the lower jaw, on its inner side, and near its angle. Use—To raise the lower jaw and draw it a little to one side.

Pterygoideus externus arises from the external pterygoid process. Inserted into the condyloid process of the lower jaw and capsular ligament. Use—To move the jaw, and to prevent the ligature of the jaw from being pinched.

MUSCLES WHICH APPEAR ABOUT THE ANTERIOR PART OF THE
NECK.

Platysma myoides arises from the cellular membrane covering the pectoral and deltoid muscles. Inserted into the side of the chin and integuments of the cheek. Use—To draw the cheeks and skin of the face downwards.

Sterno-cleido-mastoideus arises from the upper part of the sternum, and fore part of the clavicle. Inserted into the mastoid process and as far back as the occipital suture. Use—To move the head to one side, and bend it forwards.

MUSCLES SITUATED BETWEEN THE LOWER JAW AND OS HYOIDES.

Digastricus arises from a fossa at the root of the mastoid process. inserted into the lower and anterior part of the chin. Use—To draw the lower jaw downwards.

Mylo-hyoideus rises from the inner surface of the jaw-bone. Inserted into the basis of the os hyoides. Use—To move the os hyoides upwards.

Genio-Hyoideus arises from the inside of the chin. Inserted into the basis of the os hyoides. Use—To move the os hyoides upwards.

Genio-Glossus arises from the inside of the chin. Inserted into the tongue, forming part of its substance. Use—To move the tongue in various directions.

Hyo-glossus arises from the horn, basis, and cartilage of the os hyoides. Inserted into the tongue laterally. Use—To draw the tongue downwards and inwards.

Lingualis arises from the root of the tongue laterally. Inserted into the extremity of the tongue. Use—To shorten and draw the tongue backwards.

MUSCLES SITUATED BETWEEN THE OS HYOIDES AND TRUNK.

Sterno-hyoideus arises from the sternum and clavicle. Inserted into the basis of the os hyoides. Use—To draw the os hyoides downwards.

Omo-hyoideus arises near the coracoid process of the scapula. Inserted into the basis of the os hyoides. Use—To draw the os hyoides downwards.

Sterno-thyroideus arises from the upper and inner part of the sternum. Inserted into the thyroid cartilage. Use—To pull the thyroid cartilage downwards.

Thyreo-hyoideus arises from part of the basis and horn of the os hyoides. Inserted into the side of the thyroid cartilage. Use—To raise the cartilage and depress the bone.

Crico-thyroideus arises from the side of the cricoid cartilage. Inserted into the inferior horn of the thyroid cartilage. Use—To pull the thyroid cartilage towards the cricoid.

MUSCLES SITUATED BETWEEN THE LOWER JAW AND OS HYOIDES, LATERALLY.

Stylo-glossus arises from the apex of the styloid process. Inserted into the side of the root of the tongue. Use—To pull the tongue backwards.

Stylo-hyoideus arises from the basis, and about the middle of the styloid process. Inserted into the basis of the os hyoides. Use—To draw the os hyoides upwards.

Stylo-pharyngeus arises from the root of the styloid process. Inserted into the edge of the pharynx, and back of the thyroid cartilage. Use—To dilate the pharynx, and raise the cartilage.

Circumflexus arises near the Eustachian tube, and passes through the hamulus of the pterygoid process, to be inserted into the velum pendulum palati. Use—To draw the velum pendulum palati obliquely downwards, and stretch it.

Levator palati molliis arises from the point of the os petrosum, the Eustachian tube, and sphænoid bone. Inserted into the velum pendulum palati, being expanded upon it. Use—To pull the velum pendulum backwards and upwards.

MUSCLES SITUATED ABOUT THE ENTRY OF THE FAUCES.

Constrictor ist hm faucicum arises near the root of the tongue, on each side, and goes round, to be inserted into the middle of the velum pendulum palati, near the uvula. Use—To raise the tongue, and draw the velum towards it.

Palato-pharyngeus arises from the middle of the soft palate, goes round the entry of the fauces, the tendon of the circumflexus palati, and velum pendulum palati, to be inserted into the upper and posterior part of the thyroid cartilage. Use—To contract the arch of the fauces.

Azygos uvulae arises from the commissure of the ossa palati. Inserted into the extremity of the uvula. Use—To shorten and raise the uvula.

MUSCLES SITUATED ON THE POSTERIOR PART OF THE PHARYNX.

Constrictor pharyngis inferior arises from the cricoid and thy-

roid cartilages. Inserted into the middle of the pharynx. Use—To compress part of the pharynx.

Constrictor pharyngis medius arises from the horns and appendix of the os hyoides. Inserted into the ambit of the pharynx. Use—To compress the pharynx, and draw the os hyoides upwards.

Constrictor pharyngis superior arises from the pterygoid process, the lower jaw, and the cuneiform process of the os occipitis. Inserted into the middle of the pharynx. Use—To move the pharynx upwards and forwards, and to compress its upper part.

MUSCLES SITUATED ABOUT THE GLOTTIS.

Crico-arytænoideus posticus arises from the cricoid cartilage posteriorly. Inserted into the back of the arytænid cartilage. Use—To open the glottis.

Crico-arytænoideus lateralis arises from the side of the cricoid cartilage. Inserted into the side of the arytænid cartilage. Use—To open the glottis.

Thyreo-arytænoideus arises from the back of the thyroid cartilage. Inserted into the fore part of the arytænid cartilage. Use—To draw the arytænid cartilage forward.

Arytænoideus obliquus arises from the root of one arytænid cartilage. Inserted into the extremity of the other. Use—To draw them towards each other.

Arytænoideus transversus arises from one of the arytænid cartilages. Inserted into the other arytænid cartilage. Use—To shut the glottis.

Tyreo-epiglottideus arises from the thyroid cartilage. Inserted into the side of the epiglottis. Use—To pull the epiglottis obliquely downwards.

Arytæno-epiglottideus arises from the upper part of the arytænid cartilage laterally. Inserted into the side of the epiglottis. Use—To move the epiglottis outwards.

MUSCLES SITUATED ON THE ANTERIOR PART OF THE ABDOMEN.

Obliquus descendens externus arises from the lower edges of the eight inferior ribs near the cartilages. Inserted into the linea alba, ossa pubis, and spine of the ilium. Use—To compress the abdomen.

Obliquus ascendens internus arises from the spinous processes of the three last lumbar vertebræ, back of the sacrum, and spine of the ilium. Inserted into the cartilages of all the false ribs, linea alba, pubis, and sternum, by a flat tendon. Use—To compress the abdomen.

Transversalis abdominis arises from the cartilages of the seven lower ribs, and the transverse processes of the four lower lumbar vertebræ and spine of the ilium. Inserted into the linea alba throughout its whole length, and into the ensiform cartilage. Use—To compress the abdominal viscera.

Rectus abdominis arises from the outside of the sternum and xyphoid cartilage. Inserted into the side of the symphysis of the pubis. Use—To compress the abdomen and bend the trunk.

Pyramidalis arises from the anterior upper part of the pubis. Inserted into the linea alba, below the umbilicus. Use—To assist the lower portion of the rectus.

MUSCLES OF THE ANUS.

Sphincter ani arises from the skin and fat surrounding the anus on both sides. Inserted into the perineum, acceleratores urinæ, and transversus perinæi. Use—To shut the passage through the anus into the rectum.

Levator ani arises from the internal surface of the pubis, ilium, and ischium, of both sides, in a radiated manner. Inserted into the sphincter ani, acceleratores urinæ, and os coccygis, and surrounds the rectum, neck of the bladder, &c., like a funnel. Use—To draw the rectum up after the dejection of the fæces, and to assist in shutting it.

MUSCLES SITUATED WITHIN THE PELVIS.

Obturator internus arises from the foramen ovale obturator ligament, ilium, ischium, and pubis. Inserted into a large pit between the trochanters of the femur. Use—To roll the femur obliquely outwards.

Coccygeus arises from the spinous process of the ischium. Inserted into the extremity of the sacrum and os coccygis. Use—To move the coccyx forwards and inwards.

MUSCLES SITUATED WITHIN THE CAVITY OF THE ABDOMEN.

Quadratus lumborum arises from the posterior part of the spine of the ilium. Inserted into the transverse apophyses of the loins and last spurious rib. Use—To support the spine and draw it to one side.

Psoas parvus arises from the transverse process of the last dorsal vertebræ. Inserted into the brim of the pelvis, near the place of the acetabulum. Use—To bend the loins forwards.

Psoas magnus arises from the bodies and processes of the last dorsal and all the lumbar vertebræ. Inserted into the os femoris, a little below the trochanter minor. Use—To bend the thigh forwards.

Iliacus internus arises from the internal surface of the spine of the ilium. Inserted into the femur in common with the *psoas magnus*. Use—To assist the *psoas magnus*.

MUSCLES SITUATED ON THE ANTERIOR PART OF THE THORAX.

Pectoralis major arises from the clavicle, sternum, and seven true ribs. Inserted into the upper and inner part of the humerus. Use—To draw the arm forwards, or obliquely forwards.

Subclavius arises from the cartilage of the first rib. Inserted into the under surface of the clavicle. Use—To move the clavicle downwards.

Pectoralis minor arises from the third, fourth, and fifth ribs. Inserted into the coracoid process of the scapula. Use—To roll the scapula.

Serratus major anticus arises from the eight superior ribs. Inserted into the basis of the scapula. Use—To bring the scapula forwards.

MUSCLES SITUATED BETWEEN THE RIBS AND WITHIN THE THORAX.

Intercostales externi arises from the lower edge of each upper rib. Inserted into the superior edge of each lower rib. Use—To elevate the ribs.

Intercostales interni, like the former, the fibres are directed from behind forwards.

Triangularis arises from the middle and inferior part of the sternum. Inserted into the cartilages of the five last true ribs. Use—To depress the cartilages of the ribs.

MUSCLES SITUATED ON THE ANTERIOR PART OF THE NECK, CLOSE TO THE VERTEBRÆ.

Longus colli arises from the bodies of the three upper dorsal and transverse processes of the four last cervical. Inserted into the anterior tubercle of the dentatus. Use—To pull the neck to one side.

Rectus internus capitis major arises from the transverse processes of the five last cervical vertebræ. Inserted into the cunciform process of the os occipitis. Use—To bend the head forwards.

Rectus internus capitis minor arises from the fore part of the atlas.

Inserted into the os occipitis, near the condyloid process. Use—To assist the former.

Rectus capitis lateralis arises from the transverse process of the atlas. Inserted into the os occipitis, near the mastoid process. Use—To move the head to one side.

MUSCLES SITUATED ON THE POSTERIOR PART OF THE TRUNK.

Trapezius arises from the os occipitis and the spinous processes of all the vertebræ of the neck and back. Inserted into the clavicle, part of the acromion, and the spine of the scapula. Use—To move the scapula, bend the neck, and pull the head backwards.

Latissimus dorsi arises from the spine of the ilium, spinous processes of the sacrum, lumbar, and inferior dorsal vertebræ, and adheres to the scapula and inferior false ribs. Inserted into the os humeri, between the two tuberosities in the edge of the groove for the tendon of the biceps muscle. Use—To draw the os humeri backwards, and to roll it upon its axis.

Serratus posticus inferior arises from the spinous processes of the two last dorsal and three lumbar vertebræ. Inserted into the lower edge of the three or four lowermost ribs, near their cartilages. Use—To draw the ribs outwards, downwards, and backwards.

Rhomboides arises from the spinous processes of the last three cervical, and first four dorsal vertebræ. Inserted into the basis of the scapula, at its upper and lower part. Use—To move the scapula upwards and backwards.

Splenius arises from the spines of the four last cervical and four superior dorsal vertebræ. Inserted into the two first cervical vertebræ, and the side of the os occipitis. Use—To move the head backwards, and also to one side.

Serratus superior posticus arises from the spinous processes of the three last cervical, and two superior dorsal vertebræ. Inserted into the second, third, and fourth ribs, by three neat fleshy tongues. Use—To expand the thorax by elevating the ribs.

Spinalis dorsi arises from two spinous processes of the loins, and three lower of the back. Inserted into all the spinous processes of the back, except the first. Use—To extend the vertebræ.

Levatores costarum arises from the transverse processes of the last cervical and the dorsal vertebræ. Inserted into the angles of the ribs. Use—To lift the ribs upwards.

Sacro-lumbalis arises from the sacrum, spine of the ilium, and the spinous and transverse processes of the lumbar vertebræ. Inserted

into the lower edge of each rib by a flat tendon. Use—To draw the ribs downwards, to move the body upon its axis, to assist the long. dorsi, and to turn the neck back, or to one side.

Longissimus dorsi arises from the same parts as the former, and by one common broad tendon. Inserted into the transverse processes of all the dorsal and one cervical vertebræ. Use—To stretch the vertebræ of the back, and keep the trunk erect.

Complexus arises from the transverse processes of the four inferior cervical, and seven superior dorsal vertebræ. Inserted into the middle of the os occipitis, at its tubercle. Use—To draw the head backwards.

Trachelo-mastoideus arises from the transverse processes of the five lower cervical and three upper dorsal vertebræ. Inserted into the os occipitis, behind the mastoid process of the temporal bone. Use—To draw the head backwards.

Levator scapulae arises from the transverse processes of the four superior cervical vertebræ. Inserted into the upper angle of the scapula. Use—To move the scapula forwards and upwards.

Semi-spinalis dorsi arises from the transverse processes of the 7th, 8th, 9th, and 10th dorsal vertebræ. Inserted into the spinous processes of the four superior dorsal and the last cervical vertebræ. Use—To extend the spine obliquely backwards.

Multifidus spinæ arises from the sacrum, ilium, oblique and transverse processes of the lumbar, the transverse of the dorsal, and four cervical vertebræ. Inserted into the spinous processes of the lumbar, dorsal, and cervical vertebræ, except the atlas. Use—To extend the back and draw it backwards or to one side, and prevent the spine from being too much bent forwards.

Semi-spinalis colli arises from the transverse processes of the six upper dorsal vertebræ. Inserted into the spinous processes of the five middle cervical. Use—To stretch the neck obliquely backwards.

Transversalis colli arises from the transverse processes of the five upper dorsal vertebræ. Inserted into the transverse processes of the cervical vertebræ. Use—To turn the neck obliquely backwards, and to one side.

Rectus capitis posterior major arises from the transverse process of the second cervical vertebra. Inserted into the lower ridge of the os occipitis. Use—To extend the head and draw it backwards.

Rectus capitis posterior minor arises from the first vertebra of the

neck. Inserted into the os occipitis at its tubercle. Use—To assist the rectus major.

Obliquus capitis superior arises from the transverse process of the atlas. Inserted into the end of the lower occipital ridge. Use—To draw the head backwards.

Obliquus capitis inferior arises from the spinous process of the dentatus. Inserted into the transverse process of the atlas. Use—To draw the face to one side.

Scalenus arises from the upper surface of the first and second ribs. Inserted into the transverse processes of the cervical vertebræ. Use—To move the neck forward or to one side.

Interspinales arises between the spinous processes of the six inferior cervical vertebræ. Inserted into the spinous processes of the vertebræ above. Use—To draw the spinous processes towards each other.

Inter-transversales arises between the transverse processes of the vertebræ. Inserted into the transverse processes of the vertebræ above. Use—To draw the transverse processes towards each other.

MUSCLES OF THE SUPERIOR EXTREMITIES.

Supra-spinatus arises from the basis, spine, and upper edge of the scapula. Inserted into a large tuberosity at the head of the os humeri. Use—To raise the arm.

Infra-spinatus arises from the cavity below the spine of the scapula. Inserted into the upper part of the same tuberosity. Use—To roll the os humeri outwards.

Teres minor arises from the inferior edge of the scapula. Inserted into the greater tuberosity of the humerus. Use—To assist the former.

Teres major arises from the inferior angle and edge of the scapula. Inserted into the side of the groove for the long tendon of the biceps. Use—To assist in rotating the arm.

Deltoides arises from the clavicle, and the acromion and spine of the scapula. Inserted into the anterior and middle part of the os humeri. Use—To raise the arm.

Coraco-brachialis arises from the coracoid process of the scapula. Inserted into the middle and inner side of the os humeri. Use—To roll the arm forwards and upwards.

Subscapularis arises from the basis, superior and inferior edge of the scapula. Inserted into the protuberance at the head of the os humeri. Use—To roll the arm inwards.

MUSCLES SITUATED ON THE OS HUMERI.

Biceps flexor cubiti arises from two heads, one from the coracoid process, the other, called the long head, from the edge of the glenoid cavity of the scapula. Inserted into the tuberosity at the upper end of the radius, at its fore part and a little below its neck. Use—To bend the fore-arm, which it does with great strength, and to assist the supinators.

Brachialis internus arises from the os humeri at each side of the tendon of the deltoides. Inserted into the coronoid process of the ulna. Use—To assist in bending the fore-arm.

Triceps extensor cubiti arises from the neck of the scapula, and the neck and middle of the humerus. Inserted into the upper and outer part of the olecranon. Use—To extend the fore-arm.

Anconeus arises from the external condyle of the humerus. Inserted into the back part of the ridge of the ulna. Use—To assist in extending the fore-arm.

MUSCLES SITUATED ON THE FORE-ARM.

Supinator radii longus arises from the external condyle of the humerus. Inserted into the radius, near the styloid process. Use—To assist in turning up the palm of the hand.

Extensor carpi radialis longior arises from the external condyle of the humerus. Inserted into the metacarpal bone of the fore-finger. Use—To extend the wrist.

Extensor carpi radialis brevior arises from the external condyle of the humerus. Inserted into the metacarpal bone of the middle finger. Use—To assist the former.

Extensor digitorum communis arises from the external condyle of the os humeri. Inserted into the back of all the bones of the fingers. Use—To extend the fingers.

Extensor minimi digiti arises from the outer condyle of the humerus. Inserted into the second joint of the little finger. Use—To assist in extending the fingers.

Extensor carpi ulnaris arises from the outer condyle of the os humeri. Inserted into the metacarpal bone of the little finger. Use—To assist in extending the wrist.

Flexor carpi ulnaris arises from the inner condyle of the humerus and olecranon. Inserted into the os pisiforme, at its fore part. Use—to assist in bending the hand.

Palmaris longus arises from the internal condyle of the os

humeri. Inserted into the annular ligament of the wrist, and there forms the aponeurosis of the hand. Use—To bend the hand.

Flexor carpi radialis arises from the internal condyle of the os humeri. Inserted into the metacarpal bone of the fore-finger. Use—To bend the hand.

Pronator radii teres arises from the internal condyle of the humerus and coronoid process of the ulna. Inserted into the outer ridge of the radius, about the middle of its length. Use—To roll the hand inwards.

Supinator radii brevis arises from the outer condyle of the humerus, and edge of the ulna. Inserted into the anterior, inner, and upper part of the radius. Use—To roll the radius outwards, and assist the anconeus.

Extensor ossis metacarpi pollicis manus arises from the middle of the ulna, interosseous ligament, and radius. Inserted into the os trapezium, and first bone of the thumb. Use—To stretch the first bone of the thumb outwards.

Extensor primi internodii arises near the middle of the ulna, interosseous ligament, and radius. Inserted into the convex part of the second bone of the thumb. Use—To extend the second bone of the thumb outwards.

Extensor secundi internodii arises from the back of the ulna and interosseous ligament. Inserted into the third and last bone of the thumb. Use—To stretch the thumb obliquely backwards.

Indicator arises from the middle of the ulna. Inserted into the metacarpal bone of the fore-finger. Use—To extend the fore-finger.

Flexor digitorum sublimis arises from the inner condyle of the os humeri, coronoid process of the ulna, and upper part of the radius. Inserted into the second bone of each finger, after being perforated by the tendons of the profundus. Use—To bend the second joint of the fingers upon the first, and the first upon the metacarpal bones.

Flexor digitorum profundus vel perforans arises from the upper part of the ulna, and interosseous ligament. Inserted into the fore part of the last bone of each of the fingers. Use—To bend the last joint of the fingers.

Flexor longus pollicis arises from the upper and fore part of the radius. Inserted into the last joint of the thumb. Use—To bend the last joint of the thumb.

Pronator radii quadratus arises from the inner and lower part of

the ulna. Inserted into the radius opposite to its origin. Use—To roll the radius inwards.

MUSCLES SITUATED CHIEFLY ON THE HAND.

Ambricales, arises from the tendons of the flexor profundus. Inserted into the tendons of the extensor digitorum communis. Use—To bend the first and extend the second phalanx.

Flexor brevis pollicis manus arises from the os trapezoides, ligament of the wrist, and the os magnum. Inserted into the ossa sesamoidea and second bone of the thumb. Use—To bend the second joint of the thumb.

Opponens pollicis arises from the os scaphoides and ligament of the wrist. Inserted into the first bone of the thumb. Use—To bend the thumb.

Abductor pollicis manus arises from the annular ligament, and os trapezium. Inserted into the root of the first bone of the thumb. Use—To draw the thumb from the fingers.

Abductor pollicis manus arises from the metacarpal bone of the middle finger. Inserted into the root of the first bone of the thumb. Use—To pull the thumb towards the fingers.

Abductor indicis manus arises from the first bone of the thumb, and os trapezium. Inserted into the first bone of the fore-finger posteriorly. Use—To move the fore-finger towards the thumb.

Palmaris brevis arises from the annular ligament, and palmar aponeurosis. Inserted into the metacarpal bone and skin of the little finger. Use—To contract the palm of the hand.

Abductor minimi digiti manus arises from the annular ligament and os pisiforme. Inserted into the first bone of the little finger. Use—To draw the little finger from the rest.

Abductor minimi digitis arises from the os cuneiforme and carpal ligament. Inserted into the metacarpal of the little finger. Use—To move that bone towards the rest.

Flexor parvus minimi digiti arises from the annular ligament and os cuneiforme. Inserted into the first bone of the little finger. Use—To draw the little finger from the rest.

Interossei interni and *interossei externi* arise between the metacarpal bones, to the sides of which they are attached. Use—To extend the fingers, and move them towards the thumb.

MUSCLES OF THE INFERIOR EXTREMITIES.

Pectinalis arises from the anterior edge of the os pubis. Inserted

into the upper part of the linea aspera of the femur. Use—To bend the thigh.

Triceps adductor femoris. { *Adductor longus femoris* arises from the upper and fore part of the pubis. Inserted into the middle and back of the linea aspera. Use—To bend the thigh.
Adductor brevis femoris arises from the fore part and ramus of the os pubis. Inserted into the inner and upper part of the linea aspera. Use—To bend the thigh, and move it inwards.
Adductor magnus femoris arises from the lower and fore part of the ramus of the pubis. Inserted into the whole length of the linea aspera. Use—To move the thigh inwards, and assist in bending it.

Obturator externus arises from the obturator ligament, and half of the thyroid hole. Inserted into the femur near the root of the great trochanter. Use—To pull forwards and rotate the thigh.

Gluteus maximus arises from the spine of the ilium, posterior sacro-ischiatic ligaments, and os sacrum. Inserted into the upper part of the linea aspera of the femur. Use—To extend the thigh, and assist in its rotary motion.

Gluteus medius arises from the spine and superior surface of the ilium. Inserted into the great trochanter of the os femoris. Use—To assist the gluteus maximus.

Gluteus minimus arises from the outer surface of the ilium and border of its great notch. Inserted into the root of the great trochanter. Use—To assist the former.

Pyriformis arises from the anterior part of the os sacrum. Inserted into a cavity at the root of the great trochanter. Use—To roll the thigh outwards.

Gemini arises from the spine and tuberosity of the ischium. Inserted into the same cavity as the pyriformis. Use—To roll the thigh outwards.

Quadratus femoris arises from the tuberosity of the ischium. Inserted into a ridge between the two trochanters. Use—To move the thigh outwards.

MUSCLES SITUATED ON THE THIGH.

Facialis arises from the upper spinous process of the ilium. Inserted into the inner side of the membranous fascia which covers the thigh. Use—To stretch the fascia.

Sartorius arises from the upper spinous process of the ilium.

Inserted into the upper and inner part of the tibia. Use—To bend the leg inwards.

Gracilis arises from the fore part of the ischium and pubis. Inserted into the upper and inner part of the tibia. Use—To bend the leg.

Rectus femoris arises from the lower spinous process of the ilium, and edge of the acetabulum. Inserted into the upper and fore part of the patella. Use—To extend the leg.

Vastus externus arises from the root of the great trochanter, and linea aspera. Inserted into the upper and lateral part of the patella. Use—To extend the leg.

Vastus internus arises from the trochanter minor, and the linea aspera. Inserted into the upper and inner part of the patella. Use—To extend the leg.

Cruralis arises from the anterior part of the lesser trochanter. Inserted into the upper part of the patella. Use—To extend the leg.

Semi-tendinosus arises from the tuberosity of the ischium. Inserted into the upper and inner part of the tibia. Use—To bend and draw the leg inwards.

Semi-membranosus arising from the tuberosity of the ischium. Inserted into the back part of the head of the tibia. Use—To bend the leg.

Biceps flexor cruris arises from the tuberosity of the ischium. Inserted into the upper and back part of the tibia, forming the outer hamstring. Use—To bend the leg.

Popliteus arises from the external condyle of the thigh-bone. Inserted into the upper and inner part of the tibia. Use—To assist in bending the leg.

MUSCLES SITUATED ON THE LEG.

Gastrocnemius externus arises from the internal and external condyle of the femur. Inserted into the os calcis, with the tendon of the soleus. Use—To extend the foot.

Gastrocnemius internus arises from the head of the fibula, and back part of the head of the tibia. Inserted into the os calcis by a common tendon, which is called tendo-Achillis. Use—To extend the foot.

Plantaris arises from the outer condyle of the os femoris and capsular ligament. Inserted into the os calcis, near the tendo-Achillis. Use—To assist in extending the foot.

Tibialis anticus arises from the upper and fore part of the tibia. Inserted into the os cuneiform internum. Use—To bend the foot.

Tibialis posticus arises from the back part of the tibia, interosseous ligament, and adjacent part of the fibula. Inserted into the middle cuneiform bone, and upper part of the os naviculare. Use—To move the foot inwards.

Peroneus longus arises from the head of the tibia, and upper and outer part of the fibula. Inserted into the metatarsal bone of the great toe. Use—To move the foot outwards.

Peroneus brevis arises from the outer and fore part of the fibula. Inserted into the metatarsal bone of the little toe. Use—To assist the peroneus longus.

Extensor longus digitorum pedis arises from the upper part of the tibia, interosseous ligament, and inner edge of the fibula. Inserted into the first joint of the smaller toes by four tendons. Use—To extend the toes, and separate them from one another.

Extensor proprius pollicis pedis arises from the upper and fore part of the tibia. Inserted into the convex surface of the bones of the great toe. Use—To extend the great toe.

Flexor longus perforans arises from the upper and inner part of the tibia. Inserted into the last bones of all the toes, except the great toe, by four tendons. Use—To bend the last joint of the toes.

Flexor longus pollicis pedis arises from a little below the head of the fibula. Inserted into the last bone of the great toe. Use—To bend the great toe.

MUSCLES CHIEFLY SITUATED ON THE FOOT.

Extensor brevis digitorum pedis arises from the upper and anterior part of the os calcis. Inserted into the first bone of the great and other toes, except the little. Use—To extend the toes.

Flexor sublimis arises from the lower part of the os calcis. Inserted into the second phalanx of each of the small toes, by four tendons, which are perforated by those of the flex. long. dig. ped. Use—To bend the second joint of the toes.

Lumbricales pedis arises from the tendons of the flexor longus digitorum pedis. Inserted into the tendinous expansion at the upper part of the toes. Use—To draw the toes inwards.

Flexor brevis pollicis pedis arises from the fore part of the os calcis, and external cuneiform bone. Inserted into the first joint of the

great toe by two tendons. Use—To bend the first joint of the great toe.

Abductor pollicis pedis arises from the inner and lower part of the os calcis. Inserted into the first joint of the great toe. Use—To move the great toe from the rest.

Abductor pollicis pedis arises from the ligament extended from the os calcis to the os cuboides. Inserted into the outer sesamoid bone, or first joint of the great toe. Use—To draw the great toe nearer to the rest, and to bend it.

Abductor minimi digiti pedis arises from the tubes of the os calcis, and metatarsal bone of the little toe. Inserted into the first joint of the little toe externally. Use—To draw the little toe outwards.

Flexor brevis minimi digiti pedis arises from the root of the metatarsal bone of the little toe. Inserted into the root of the first bone of the little toe. Use—To bend the little toe.

Transversalis pedis arises from the ligament connecting the bones of the tarsus. Inserted into the tendon of the abductor pollicis. Use—To contract the foot.

Interossei pedis interni and *interossei pedis externi* arise and are inserted between the metatarsal bones. Use—To draw the smaller towards the great toe, and assist in extending the toes.

PHYSIOLOGICAL INFERENCES.

Having treated of the structure and use of muscles, I will now draw a few practical inferences. And first, we see, in relation to this part of the system, the same law as in other parts, which is the necessity of exercising them, in order to secure their healthy tone and use; if this be omitted they become enfeebled and incapable of exciting that force for which they are naturally designed. For instance, let a person cease to labor for a period, and how soon does his strength decline, and he is rendered incapable of lifting much weight or performing much manual labor. His muscular powers are impaired and he can exert but very little strength; nor can he continue that strength but a very short time. On the other hand, if a person is feeble, yet begins to use one or more of his muscles moderately and perseveringly, they become more and more vigorous, till ultimately a prodigious power is acquired. To illustrate this, I will mention but a single fact. A relative of mine, quite feeble before he began to labor, took hold of a lever and turned a screw with facility, which I could not even move. I had not exercised my muscular power for years, or scarcely at all, while

he was in the daily habit of it. The inference then is plain, that moderate, but regular, periodical exercise of our muscles is requisite to secure their health and use.

Mr. Fowler, in his work on Physiology, has some pertinent and practical remarks on this subject. He says—"Those who will eat more than labor, must suffer. This law cannot be broken with impunity. In fact, the broken constitutions of most of those who go from the farm and the workshop to college, or some sedentary occupation, are caused mainly by violating this law of proportion. They continue to eat as before, yet do not work off that food, and hence the head-aches, ennui, debility, nervousness, dyspepsia, and kindred diseases of our literary and sedentary classes. Study does not make them invalids, but is actually promotive of health and longevity. They are enfeebled by overtaxing their stomachs while they starve their muscles for want of action.

"Take that city belle, rendered delicate, nervous, sickly, miserable, by excessive nervous and cerebral derangement consequent on novel reading, parties, amusements, and all the excitement of fashionable city life. Medicines can never cure her, but work can. Her malady consists in a predominance of nerve over muscle, and her remedy in restoring the balance between them. She is doomed either to wear out a miserable existence, or else to EXERCISE HER MUSCLES; nor can salvation come from any other source. And one of the great reasons why journeyings, visits to springs, voyages, and the like, often effect such astonishing cures, is that they relieve the nervous system, and at the same time increase muscular and vital action. The same exercise taken at home will cure them quite as speedily and effectually by the same means—a restoration of proportion between their functions. Nine in every ten of the invalids of our land are undoubtedly rendered feeble by this one cause, and can be cured by labor. How many thousands, so weakly and sickly that they begin to despair of life, finally give up their business and move upon a farm, and soon find themselves well. Exercise has often cured those who have been bedridden many years, as seen in the following:

"A physician of some repute in Lowell, Mass., was called thirty miles in great haste, to see a sick woman, whose case had thus far baffled all medical treatment, and was regarded by all her friends as hopeless. All they expected was merely to mitigate a disease of long standing: recovery being considered out of the question. The doctor came, saw that she was very nervous, and had been

dosed almost to death, and told her that if she would follow his directions implicitly, he could cure her; for he had one kind of medicine of great power, but which was useful only in cases exactly like hers, in which it was an infallible cure. After telling her how often she must take it, he added, that she must get up and **WALK ACROSS THE ROOM** the second day, and **RIDE OUT** the third. "Oh, that she could never do, for she had not been off her bed in many years, and was so very weak," etc., etc. "Oh, but," said the doctor, "this medicine will give you much strength that you will be able to do so, and it will prevent any injurious consequences arising therefrom. And, besides," he added, "the medicine will not operate, unless you stir about some. Do just as I tell you, and you will be off your bed in ten days." She sent an express thirty miles, the medicine being so rare that he did not take it with him, after his bread pills, rolled in aloes, to make them taste like medicine, and took them and the **EXERCISE** as prescribed, and the third day she actually got into a carriage, and in ten days was able to leave her bed, and soon after was able to work, and yet lives to be a blessing to her family, and to pour upon the doctor a literal flood of gratitude for performing so wonderful a cure—a cure which none of the doctors had been able to effect, and which nothing but restoring the lost proportion between her nerves and muscles could have effected. Nor do I hesitate to affirm, as my deliberate conviction, that nineteen-twentieths of the invalids, especially females, of our land, are rendered so mainly by excessive nervous and deficient muscular and vital action, and can be cured by banishing care, and exercising in the open air.

"THE AMOUNT OF EXERCISE REQUIRED.

"From four to six hours of vigorous muscular exercise is the least compatible with first-rate health. Excellent constitutions may endure close confinement for years, yet must run down continually, and finally break. A lower degree of health may be preserved on less exercise, but as the order of nature is to spend from six to ten hours daily in the open air, so the perfection of health requires a great amount of muscular action, and the more, generally speaking, the better, provided it is of the right kind. My own convictions are, that about four hours brisk labor per day will suffice for exercise, which amount, well expended by all—rich and poor—will just about supply the human family with the comforts, if not also the luxuries of life, artificial wants and extravagances of course

excepted. How admirable this adaptation of the amount of labor requisite for health to that required to provide man with the necessities of life.

“In the light of this required amount of exercise, what shall we say of those merchants, clerks, lawyers, students, and the sedentary classes generally, who confine themselves to their offices, desks, and books, from morning till night, year in and year out, scarcely going out of doors, except to and from their business, and then **TAKING AN OMNIBUS!** If these principles of exercise were put in practice, very few city conveyances would be required or patronized. One would think that our sedentaries, starved almost to death for exercise, would embrace every opportunity to take it, walking at least to and from their business, sawing their own wood, and the like. Yet fashion requires that they hire horses to do the former, and servants to do the latter. Such fashions I despise, practically and theoretically.”

While on the one hand very many persons suffer from want of sufficient exercise, we believe that an equal number suffer from the opposite cause, namely, excessive labor, as farmers and mechanics. The country as well as the city give many melancholy instances of persons who have broken down their systems from over exertion; lifting, straining, and long-continued exertion, arising either from necessity or an inordinate desire to accumulate money. This practice is much worse than indolence. Look at poor girls in cities, who toil incessantly for ten or fifteen hours during the day, in factories or other places, perhaps in a sitting position, constantly at work in a close atmosphere. Many children and youth also are compelled to labor much more than their strength permits, which often entails disease upon them. Hence a due medium must be observed to ensure health. When any muscle of the system becomes weak from any cause in addition to proper exercise, friction or rubbing the part will be found useful. Also a douche or stream of cold water, followed by rubbing with a coarse towel.

There are hundreds of worthy but indigent girls who are compelled to labor far beyond their strength to obtain a bare subsistence, while there are thousands who triumph in the possession of their riches, and live in luxury and pleasure. How can such men reconcile this with their consciences, if they have any, or if they are not “*seared with a hot iron*”? There is one miserable old miser in this city, Astor, now about eighty years of age, worth at least *ten millions*, who, if the iceberg could be taken from his heart,

FIG. 7.



1 1 Hemispheres of the Brain, Cerebrum. 2 2 Hemispheres of the Cerebellum or little brain. 3 3 3 Spinal cord or marrow, continuous with the brain, and covered with pia mater. The spinal nerves proceeding from it on each side.

might render comfortable all the poor in the United States by purchasing farms for their use. Strange it is, and it shows the perversion of our best feelings, that almost everybody worships this wretched old man, not for his good traits, but for his money!!

Well might the Apostle say, "*Go to, ye rich men, weep and howl for the miseries that shall come upon you.*" This state of things here, and more especially in Europe, fulfils the prediction of Pollock in his *Course of Time*, where he says,

"Starving want in time of wealth."

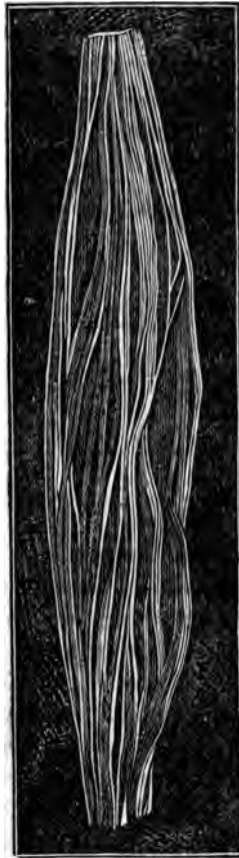
CHAPTER VI.

THE NERVOUS SYSTEM.

WE have now to enter on the consideration of those parts that essentially distinguish an animal from a vegetable, and the organs of the animal from those belonging to the organic life; or, in other words, we have to speak of the parts that give us the power of voluntary motion, and which enable us to feel and to think.

In all but the most simple animals, it is quite certain that sensation and voluntary motion depend on the nervous system. The nervous system of man consists of the brain, the spinal marrow, and the nerves. As these are all composed of nearly the same kind of substance, we may view the spinal marrow and brain as nervous matter collected into masses, and the nerves as the same matter diffused over every part of the body. The brain, as has already been mentioned, is contained in and protected by the cranium or skull. It is also enclosed in three layers of fine membrane, the outermost of which (*dura mater*) is strong and tough, and adheres to the skull at different points; the middle layer (*arachnoid*) is so fine as scarcely to be visible; and the innermost one (*pia mater*) not only envelopes the brain, but also penetrates into certain parts in its interior. The spinal marrow has similar coverings, and is contained in the canal formed by the rings of the united vertebræ. The nerves are cords, attached to the brain and spinal marrow, which are composed of brainy matter enclosed in numerous minute

sheaths, bound together by a strong covering (neurilema) as seen in the following figure.



When we examine the outer surface of the brain,* we observe it folded or convoluted, as seen in Fig. 32, *a, a, a*; and when it is cut

* The functions of the different nerves, which will be immediately adverted to, may be made plain by having a large drawing, so colored as to distinguish each kind. The following may be placed beneath the drawing:—

NERVES OF SENSATION (colored red). (Fig. 32.) No. 1, olfactory—No. 2, optic—No. 5, 5' branches of the fifth nerve—7' auditory nerve.

NERVES OF MOTION (colored blue). Nos. 3, 4, 6, go to the muscles of the eye—No. 7 (portio dura) goes to the sides of the head and face—8'', the spinal accessory nerve, goes to the muscles of the shoulder—9, goes to the muscles of the tongue.

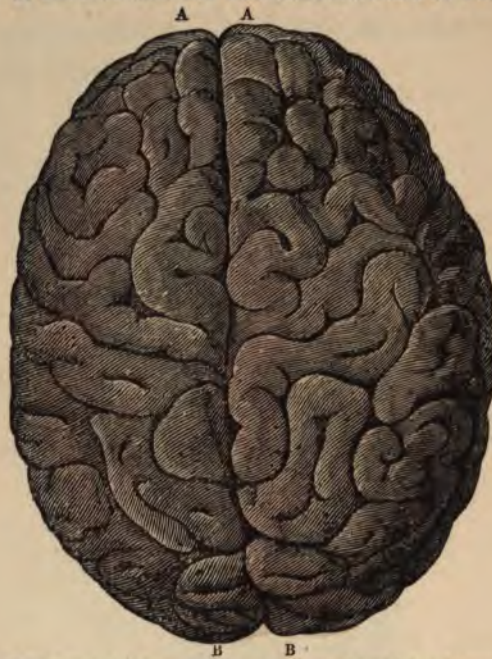
NERVES BOTH OF SENSATION AND MOTION, OR MIXED NERVES (colored brown) 5'', the lowest branch of the 5th nerve (the brown color to commence where the upper branch of 7 crosses it—10, 11, 12 and all below this.

DOUBTFUL NERVES colored (black). 8, the glossopharyngeal—8', the par vagum.



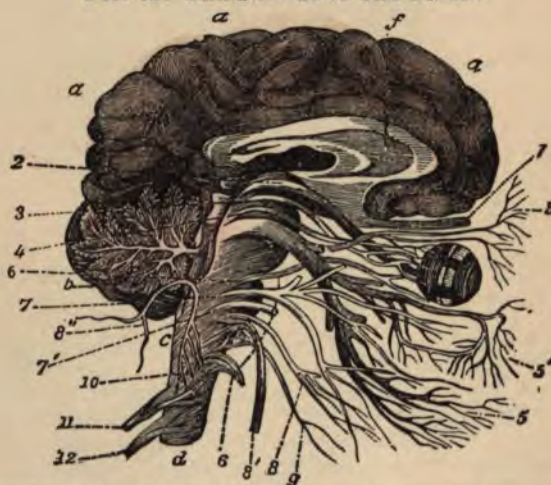
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FIG. 8. A VIEW OF THE TOP AND CONVOLUTIONS OF THE BRAIN.



A A Front part of the Brain. A A B B Right and left Hemisphere.

FIG. 32. THE NERVES OF THE BRAIN.



a a a Convolutions of the Brain. *b* Cerebellum, and arbor vitæ, or tree of life. *c* Medulla Oblongata. *d* Upper part of the spinal cord. *e* Eye. *f* Lateral ventricle. *g* Corpus Callosum. *h* Pineal Gland. *s* Quadrigeminal bodies. 1 Olfactory nerve. 2 Optic nerve. 3, 4, 5, 6, Third, fourth, fifth and sixth nerves. 5', 5'', Branches of the fifth nerve. 7, Portio Dura of the seventh nerve. 7', Auditory nerve. 8, Glosso-pharyngeal nerve. 8', Par Vagus. 8'', Spinal accessory nerve. 9, Hypoglossal nerve. 10, Sub-Occipital nerve. 11, 12, First and second cervical nerves.

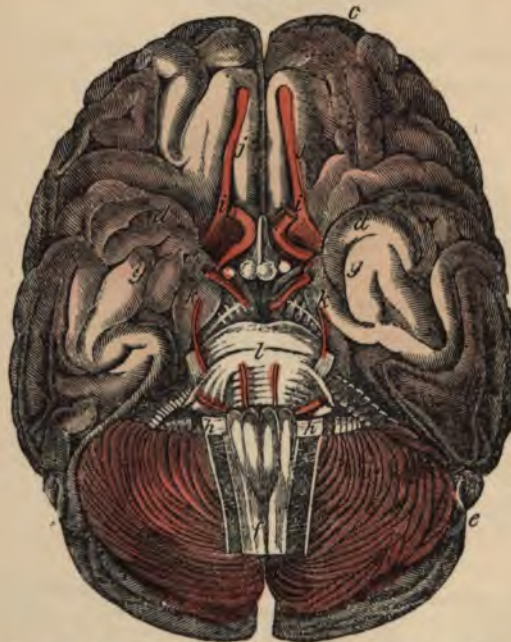


FIG. 17.



A perpendicular section of the brain, showing the grey and white substances. Fibres of the brain, which originate in the medulla oblongata, and ultimately expand into the convolutions of the brain.

FIG. 18.



Section of the Brain. The Student will study the references.

into, we find it composed, 1st, of a grey pulpy substance, mostly placed externally, and, 2dly, of a similar white substance, placed internally. The same materials exist in the spinal marrow, but the white matter is external, while the grey is internal. What is commonly called the brain, is divided into the cerebrum or proper brain (Figs. 32, *a*, and 33, *a*), and the cerebellum or lesser brain (Figs. 32, *b*, and 33 *b*), which presents in its interior the branched appearance of a tree (*arbor vitæ*), as may be observed in Fig. 32. Both these parts are divided longitudinally into two halves or hemispheres, and also transversely into lesser parts called lobes.

In the interior of the brain there are several cavities called ventricles, two of which are of considerable size. Into these cavities

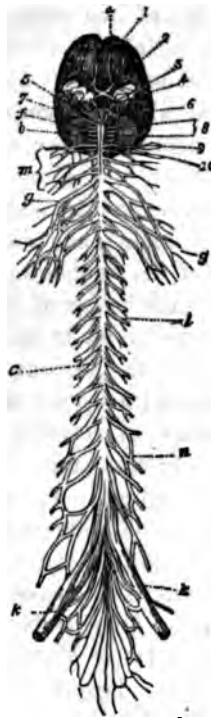


Fig. 33. Base of the Brain and Spinal Cord.*

* View of the base of the brain, anterior part of the spinal marrow, and attached nerves. *a*, Cerebrum; *b*, cerebellum; *c*, spinal marrow; *f*, medulla oblongata. 1, Olfactory nerves; 2, optic nerves; 3, 4, 5, 6, 3*d*, 4*th*, 5*th*, and 6*th* nerves; 7, portion of the 7th and auditory nerves; 8, glossopharyngeal nerves and pneumogastric nerves; 9, spinal accessory and hypoglossal nerves; 10, suboccipital nerves; *m*, cervical plexus of nerves; *g*, plexus of the nerves going to the arms; *l*, dorsal nerves; *n*, lumbar nerves; *k*, plexus of nerves going to the lower extremities.

called ventricles, one of which is seen in Fig. 32, *f*, there is continually poured out a clear fluid, which in the healthy state, is immediately absorbed; but in a diseased state, this sometimes accumulates until it amounts to gallons, forming one variety of the disease called hydrocephalus, or water in the head.

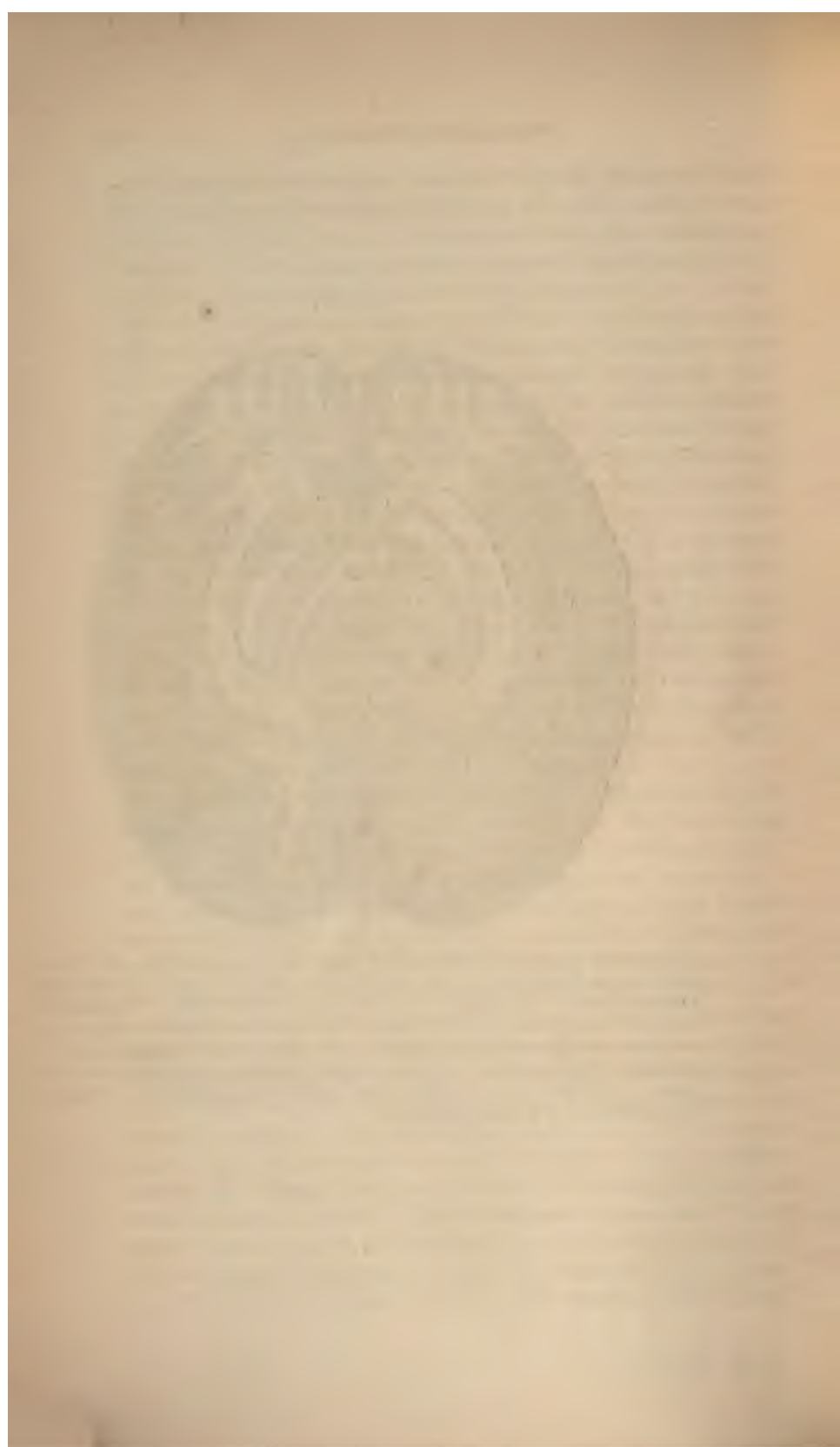
The spinal marrow is found to be composed of six columns, as represented in the Fig. Two are anterior, two lateral, and two posterior. These columns, again, when minutely examined, are found to consist of bundles of fibres, that can be traced upwards into, and are found to be continuous with, similar fibres composing the brain and cerebellum. The upper portion of the spinal marrow (Figs. 32, *c*, 33, *f*), which receives the name of the medulla oblongata, is composed, 1st, of two parts called the corpora pyramidalia, which appear to be chiefly continuous with the anterior columns of the spinal cord and to run upwards to the cerebrum; 2dly, of two similar parts, called the corpora olivaria, chiefly continuous with the lateral columns of the spinal cord, and likewise principally running up the cerebrum; and, 3dly, of two other parts, called corpora restiformia, behind the corpora olivaria, continuous with the posterior spinal columns, and chiefly running to the cerebellum. The two lobes of the cerebellum are also connected with each other by a part called the bridge of Varolius.

These descriptions are necessary to make intelligible the functions of the different parts of the nervous system. We shall now state a few of these. When the spinal marrow is divided in the loins, sensation and all power of voluntary motion are immediately lost in the lower extremities; when the spinal cord is divided above where the nerves (Fig. 33, *g*,) come off to the arms, the latter, and all the parts below, suffer in the same manner, but the animal can still breathe; when the medulla oblongata (Fig. 33, *f*,) is divided or injured, respiration immediately ceases, and death of course is instantaneous. If, again, the division is made above the medulla oblongata, and below the bridge of Varolius, respiration continues, and the animal may live for a longer or shorter time. Chossat, a French physiologist, who performed some experiments of the latter kind on dogs, thinks they die from an inability to keep up their natural temperature. Tortoises, however, in which the brain has been taken out, have lived for four or six months afterwards. The brain of a young puppy was removed, and it not only continued to breathe, but also sucked, when applied to the teat, or when the finger, moistened with sugar, was put in its mouth. There have

FIG. 16.



B B Anterior portion of the brain. C C Ganglions of the cerebellum. E E Corpus callosum. A, Third ventricle. a a Anterior quadrigeminal bodies. c c Posterior quadrigeminal bodies. t Connexion of posterior quadrigeminal bodies. e Connexion of the great sympathetic nerve. d d Division of the striated bodies into two parts, to show the passage of the great bundles of fibres, b. s Pineal gland with its anterior cords. m Interior of fourth ventricle. n n Great inferior ganglions. p p Great superior ganglions. x x White fibres in fourth ventricle. v Posterior commissure. r Middle or soft commissure. o Anterior commissure.



also been many cases of children born almost wholly without nervous matter, above the medulla oblongata, which yet have lived and grown for days, or even for several months.

The parts above the medulla oblongata, viz., the cerebrum and cerebellum, are generally considered as the especial seat of intellect and moral feeling. Says Haller, "Concerning the seat of the soul, we must inquire experimentally. In the first place, it must be in the head, and not in the spinal marrow. For though the latter be affected, the integrity of the mind remains the same. Again, it appears, from the experiment of convulsions arising when the inmost parts of the brain are irritated, that it lies not in the cortex, but in the medulla; and not improbably, in the crura of the medulla, the corpora striata, thalami, pons, medulla oblongata, and cerebellum. Finally, by another not absurd conjecture, it lies at the origin of every nerve, so that the concurrence of the first origins of all the nerves, make up the sensorium commune. Are the sensations of the mind represented there, and do the voluntary and necessary motions arise in that place? This seems very probable. For it does not seem possible, that the origin of motion can lie below that of the nerve; for that would be a gratuitous supposition of immobility or insensibility, in some part of the nerve, though perfectly similar to the rest. Nor can the origin of motion be placed higher in the arteries, for they neither have feeling, nor are excited to voluntary motion. It therefore follows, that the seat of the mind must be where the nerves first begin.

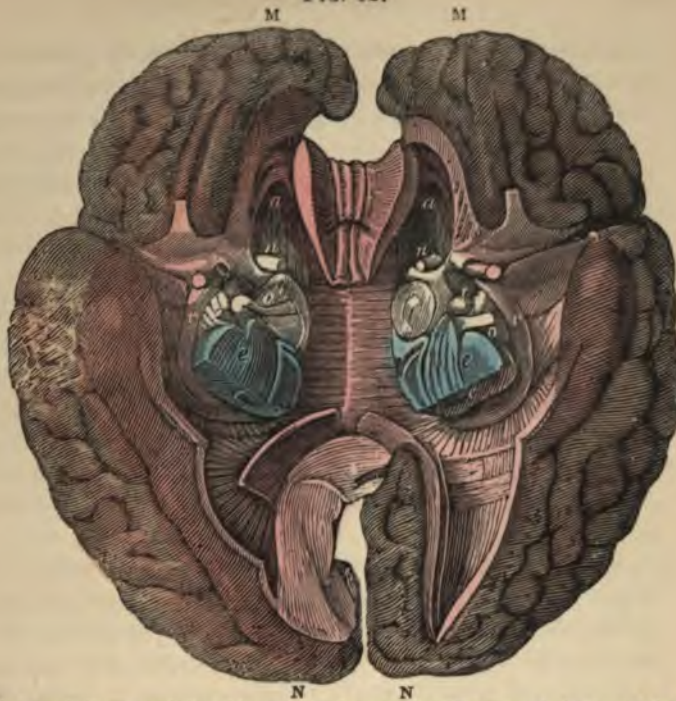
We come now to the explanation of the manner in which the nerves are the organs of the sense or motion; which, as it lies hid in the ultimate elementary fabric of the medullary fibres, seems to be placed above the reach both of our senses and reason; but we shall endeavor to make as great an approximation to the truth as possible, by experiments. First, it is demonstrated, that sensation does not come through the membranes from the sentient organ to the brain, and that motion is not transmitted through the coverings from the brain into the muscle. For the brain itself, deeper than these membranes, receives the impressions of sense, and when injured throws the muscles into convulsions. Moreover, it is certain, that the nerves arise from the medulla of the brain; the truth of which is manifest in all the nerves of the brain, more especially in the olfactory, optic, fourth and seventh pair, which continue their medullary fabric a long way before they receive the covering of the pia mater."

Upon the different functions supposed to be performed by different parts of these, is founded the modern science of phrenology. They are thought to be no further necessary to sensation and voluntary motion, than as receptacles to treasure up the one, and an organ to direct the other. The brain itself is not possessed of sensibility, for when the skull has been fractured, and the brain has protruded, part of it has been repeatedly shaved off, without occasioning the least pain, and, in some of the lower animals, the whole of the upper nervous mass has been cut away, without the animal manifesting any uneasiness, until the instrument came close to the medulla oblongata. Cases of disease of the brain have been recorded which lead to the same conclusion. Dr. Abercromby mentions having seen a lady who died suddenly with scarcely a single symptom, and who was so well the evening before death as to have been at a dancing-party, one half of whose brain was ascertained, after death, to have been completely destroyed.

From the organization of the brain we may infer that it is a galvanic battery, and that all the phenomena of nervous influence is produced by its action. The two hemispheres are only united together at one point, the *carpus callosum*, and the nervous fluid or influence crosses this in opposite directions, as is proved by post mortem examinations. An injury on one side of the head has caused a *paralysis* of the extremities below, on the opposite side. Dr. VERE, of this city, witnessed this fact, and so have others; which proves that one hemisphere controls the opposite parts of the body and *vice versa*. Haller thus remarks, page 182, "The nervous fluid, which is the instrument of sense and motion, must be exceedingly movable, so as to carry the impressions of sense, or commands of the will, to the places of their destination, without any imaginable loss of time, and cannot receive the cause of its motions only from the heart. Moreover, it is very thin and invisible, and destitute of all taste and smell; yet reparable from the aliments. It is not on any account to be confounded with that visible, viscid liquor exhaling into the intervals of the nervous chords."

Electric matter is the most powerful and best calculated to excite motion and even a ligature on a nerve, although it takes away sense and motion, never stops an electrical current. The effect of pressure on the brain is surprising and demonstrates its functions. A person in Paris had received an injury of the brain from which he had recovered, but left a portion of it bare. For a trifle he

FIG. 12.



The cerebellum, medulla oblongata, and pons Varolii removed, the brain then cut along the median line and laid open, to show its ventricles and their fibrous structure. *M M* The anterior part of the brain. *N N* Posterior part of the brain. *ee* Vertical sections of the great inferior ganglions—color, bluish white. *cc* The black substance in the centre of the great inferior ganglions. *oo* The cords of the mammary bodies which plunge into the interior of the great inferior ganglions. *t* Mammary body of the right side, the left being cut away. *rr* Optic nerves. *nn* Olfactory nerves. *aa* Great superior ganglions—color, reddish grey.

FIG. 13.



A—Front part of the right hemisphere of the brain. *B*—Great inferior ganglion. *C*—Great superior ganglion.



would permit any person to press upon the exterior of this organ, when he would suddenly fall down, as in a fit; as soon as the pressure was removed, recovery immediately followed. Whether sensation as well as motion was thus suspended is not stated.

M. Majendie has made some curious discoveries connected with the effects of lesion of the parts situated above the medulla oblongata. When parts situated in the ventricles (*corpora striata*) are cut, the animal immediately darts forward and runs with rapidity. This phenomenon, he says, is particularly remarkable in young rabbits, the animal appearing to be impelled forward by a power within, which it cannot resist. It is a curious fact connected with this observation, that horses are subject to a disease that produces similar effects. The diseased animal easily goes forward, and will even trot or gallop quickly, but seems incapable of going backwards, and appears to have difficulty in arresting its progressive motion. On the other hand, when the cerebellum or medulla oblongata was injured in a certain manner, the tendency always was to move backwards. Some pigeons which had been thus injured constantly moved backwards in walking for more than a month, and even flew backwards when thrown into the air. Another singular movement took place when the parts leading from the spinal cord up to the cerebellum (*crura cerebelli*) were cut. When the one on the right is cut, a whirling motion takes place on that side, and sometimes with such rapidity that sixty turns are made in a minute. M. Majendie says he has seen this continue for eight days, without stopping, to speak properly, for a single instant. When the opposite *crus cerebelli* is cut, rotation takes place on the opposite side; and when both are cut, motion in both directions ceases. Probably some disease of these parts existed in an insane person who was some years ago confined in one of the Edinburgh asylums, and who incessantly occupied himself in turning round in one direction. He might be stopped, or forced to turn in an opposite direction, but when left to himself, immediately turned as before.

We are indebted to Sir Charles Bell, however, for perhaps the most brilliant discovery ever made connected with the functions of the nervous system. We refer to his discovery of the different parts upon which motion and sensation depend. This distinguished physiologist was led to his investigations partly from considering the distribution of certain nerves, and partly from cases in which a person wholly loses the power to move a part of the body, and yet

retains perfect sensation in it, or where the reverse of this happens—that is, where the power of motion remains while sensation is gone. Of such cases, the following may be taken as an example :—Francisco Cæsario, living at Rio Janeiro, fell from a scaffold twenty feet high. On recovering from the shock, it was found that his left side, from the shoulder downwards, was deprived of all power of motion, but that sensation remained in it ; whereas, on the right side, his powers of motion were perfect, but sensation was then and afterwards so completely gone, that a lancet might be thrust deep into the flesh without giving him the slightest pain. From the middle of the neck upwards, motion and sensation on both sides were uninjured, and the line of demarcation was so exactly drawn, that it might be defined by a thread surrounding the neck.

Now, of such cases as the above, Sir Charles Bell's experiments afford a most satisfactory explanation ; for though a limb is deprived both of the power of motion and sensation by dividing the spinal nerves that go to it, Sir Charles Bell showed, that by tracing these nerves to their origin, they are each found to be composed of two parts, one of which comes from the anterior column of the spinal cord, while the other comes from the posterior column, and, as represented, has always a small ganglion or swelling on it. He further showed, that if the anterior root be cut, the power of motion in the part supplied by the nerve is extinguished, as is also sensation, by dividing its posterior root. In his experiments, when the posterior or sensitive roots of the nerve in a newly killed animal were irritated with a sharp instrument, no effect was produced ; but when the anterior or motive roots were irritated, the parts of the body to which these nerves went, were thrown into convulsions. An ass was killed, and immediately the motive nerve which supplies the muscles of the jaws was irritated. The muscles contracted strongly, and closed the jaw with a snap ; but when the same nerve was divided in a living animal, the jaw fell relaxed.

These explanations will render intelligible the account we shall now give of the different nerves derived from the brain and spinal cord.* They come off in pairs, as represented in Fig. 33. Figure 32 shows, as already mentioned, a longitudinal section of the brain and medulla oblongata. No. 1 (in both Figures) is the 1st or olfactory nerve, which goes to the nose, and gives the sense of smell ;

* The derivation of the nerves from the brain is considered only apparent, many physiologists believing that they can be traced to the spinal cord.

FIG. 21.

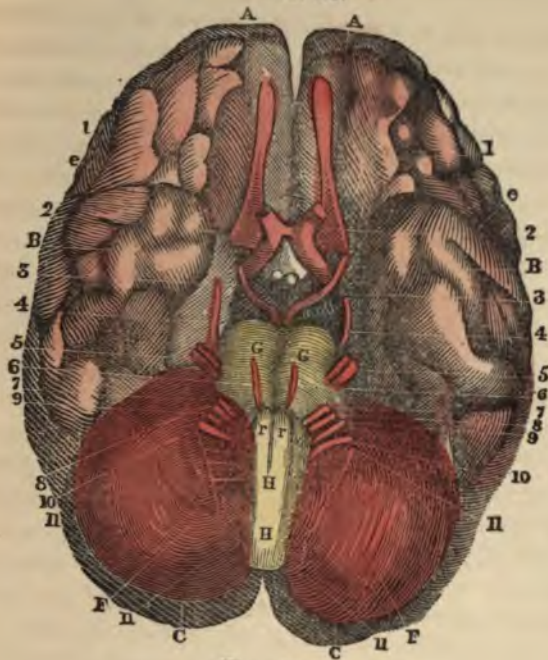
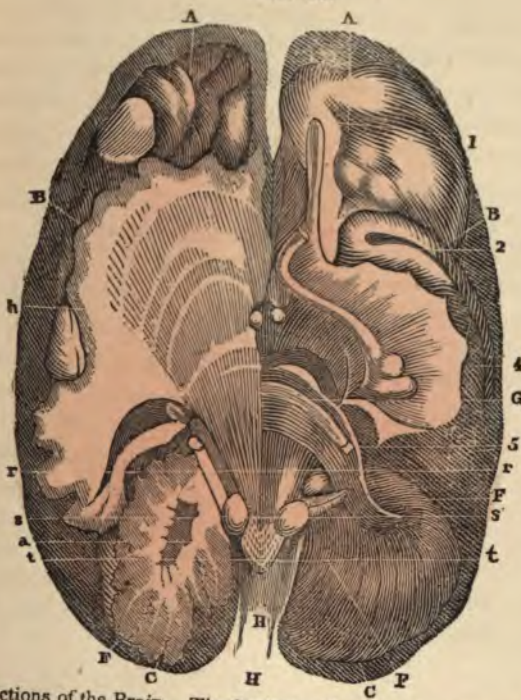
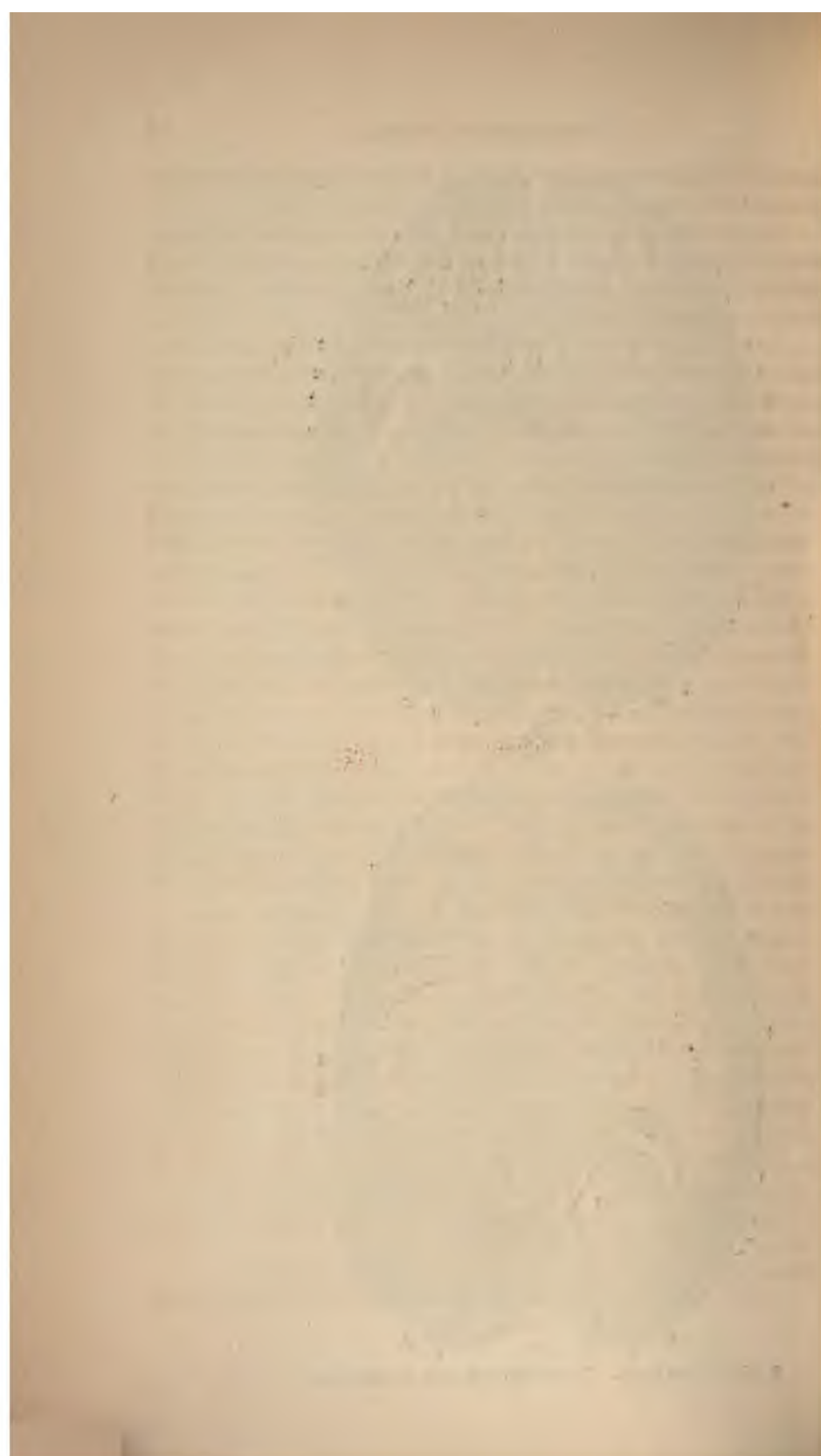


FIG. 22.



Sections of the Brain. The Student will study the references.



and No. 2 (also seen in both Figures), is the 2d or optic nerve, that goes to the eye, and gives the power of vision.

No. 3 (seen in both Figures) is a nerve that goes exclusively to the muscle of the eye. It has its origin from the anterior column of the spinal cord, which runs up to the cerebrum, and is, therefore, only a nerve of motion.

No. 4 (seen in both Figures) is the smallest nerve in the body, being, in man, little thicker than a sewing thread. It goes to a single muscle which moves the eye (trochleator); it is a nerve of motion, and probably has an origin similar to the last, though this has not been distinctly shown.

No. 5 (seen in both Figures, but best in Fig. 32) is a most extensive and important nerve. It is the highest that arises by double roots, and is, as shown by Sir Charles Bell, both a motor and a sensitive nerve. Its first branch (Fig. 32, 5), which goes to the eye, eyebrows, forehead, &c., comes only from the posterior or sensitive root, and gives to the parts mentioned the sense of touch or common sensation. If this nerve were destroyed, we might have sensations from light, but we could have no feeling when anything else came in contact with the eye. The second branch (Fig. 32, 5'), like the first, comes from the posterior root, and gives sensibility to the upper jaw, palate, upper lip, &c. The third branch (Fig. 32, 5'') has its origin from both the motor and sensitive roots, and hence gives both sensibility and the power of motion. It goes to the muscles, skin, &c., connected with the lower jaw, tongue, and mouth. The sensitive branches of the 5th nerve are those that are so painfully affected in toothache and tic douloureux.

No. 6 (Figs. 32 and 33) is the 6th nerve. It has only one root from the anterior part of the spinal cord, and is hence exclusively a motor nerve. It goes to a single muscle of the eye.

No. 7 (Figs. 32 and 33) is the motor, or hard portion, as it is sometimes called (*portio dura*), of the 7th nerve. It is extensively distributed to the muscles of the face and forehead. When it is cut, the muscles on that side are paralysed, and the mouth, as formerly noticed, is drawn to the other side.

No. 7' (Fig. 32) is called the soft portion of the 7th nerve. It goes to the internal ear, and is the nerve of hearing.

No. 8 (Figs. 32 and 33) is called the glossopharyngeal nerve, from being distributed to the root of the tongue and pharynx. The functions of this nerve are at present the subject of dispute.

No. 8' (Figs. 32 and 33) are called the pneumogastric nerves,

from being distributed principally to the lungs and stomach. These are large nerves that run behind the carotid arteries in the neck. Although they have been very frequently experimented on, their functions are still a subject of dispute. There seems no doubt that they give motor branches to the top of the windpipe, the pharynx, the œsophagus, and probable also to the lungs, and they also seem to furnish us with some of the sensations from the lungs. When the pneumogastric nerves are cut below the branches to the windpipe, the effect is, as formerly mentioned, generally, though not uniformly, to suspend the process of digestion, the food remaining in the stomach nearly unaltered. It was to these nerves that Dr. Philip, under these circumstances, applied galvanism, and found that the power of digestion was then restored.

No. 8" (Fig. 32) is called the spinal accessory, and is considered to be a motor nerve. It is distributed to the muscles of the neck and shoulder. This is called by some anatomists the third branch of the eighth pair, the glossopharyngeal and pneumogastric being considered its first and second branches. The next or hypoglossal nerves, in this way, come to be called the ninth pair.

No. 9 (Figs. 32 and 33) is a nerve of motion, called the hypoglossal from going to the muscles, and consequently producing the movements of the tongue.

No. 10 (Figs. 32 and 33) is called the suboccipital nerve, from coming out immediately below the occiput or back of the head. It goes to the back of the neck, &c., and belongs to the strictly regular nerves, or those which have both sensiferous and motor roots. All the spinal nerves below this, as seen in Figs. 32 and 33, also have sensitive and motor roots. They become interwoven in their course, forming, in different parts, what is called a plexus. The principal of these are, 1st, the cervical plexus (Fig. 33, *m*), which gives off, among others, two important nerves, one of which goes to the diaphragm, and is called the phrenic or internal respiratory nerve, and the other, from being also concerned in respiration, is called by Sir Charles Bell the external respiratory nerve. *g*, Fig. 33, is called the brachial plexus, from supplying nerves to the arm. Below this are the dorsal nerves (*l*), the lumbar nerves (*n*), and the sacral plexus (*k*), which last furnishes the large nerves that go to the lower extremity.

It is evident that the influence of the will is confined to the nerves, and does not extend to the arteries or other solid parts of the body.

FIG. 19.



The brain proper or cerebrum is divided by anatomists into three lobes. *A A* Anterior, *D D* middle, and *B B* posterior lobes. *A B A B* are the right and left hemispheres of the brain. *F F* The cerebellum. *e* The pons Varolii, or Tuber Annulare. *f* The Medulla Oblongata. *rr* The Corpora Pyramidalia. *ss* The Corpora olivaria. *tt* The Corpora restiformia. 1 First pair, or olfactory nerves. 2 Second pair, or optic nerves. 3 Third pair nerves, or motores oculorum. 4 Fourth pair nerves, or trochleares. 5 Fifth pair. 6 Sixth pair. 8 Portio dura of the seventh pair. 7 Portio Mollis of the seventh pair. 9 Glosso-pharyngeal nerves. 10 Par vagum.





View of the brain and nerves.

Besides the nerves described above, there is a most extensive system of nerves called ganglionic (from small ganglia or swellings with which they are connected), that are principally distributed to the lungs, bowels, and other viscera. Their functions are not precisely ascertained, but they do not confer either sensibility or the power of voluntary motion. They are generally supposed to be chiefly connected with secretion, and, from their connexions with the spinal nerves, to form a bond of union between the rest of the nervous system.

By whatever parts effected, there can be no doubt that a union or sympathy of the different organs does exist. The effects, in paralysing the heart's action, of a blow on the region of the stomach, of extensive burns, &c., have already been stated. If the brain of a rabbit be merely removed, the heart may beat for an hour or more afterwards, but suddenly crushing the brain instantly stops its

action. Tickling of the soles of the feet, causing the action of the diaphragm that takes place in laughing, tickling of the throat causing vomiting, &c., are examples of a similar connexion.

A subject of the utmost interest to the physiologist is presented in the modifications which the corresponding parts of the nervous system undergo in the different classes of animals. In none of the lowest tribes of the Radiata have any traces of a nervous system been discovered, though these creatures seem to possess both feeling and voluntary powers. In the long round worm which infests the human intestines, a slender nervous filament passes along the lower part of the belly, and is divided by the gullet into two branches. The nervous filaments in the star-fish encircle the mouth, and radiate to its five divisions. In the Articulata the nervous cords are interrupted by knots or ganglia, which, it is probable, perform functions analogous to the brain and spinal marrow of the Vertebrata. The nervous system of the Mollusca contrasts with that of the Articulata, in assuming more of a circular form. In that of the sepia, there is a large ganglion, which is enclosed in something like a rudimentary cranium, and probably performs functions analogous to those of the brain. The parts from which the optic nerves are derived in this animal, are even larger than the part representing the brain.

In the vertebrated division, a brain and spinal marrow are always present, but the size of the parts composing the brain especially, is relatively so much altered, as almost to prevent them from being recognized. Among animals of this division, fishes have the most simple nervous system. From these there is a regular gradation in complexity of organization up to man, in whom all the parts belonging to the other classes are found, besides some that are peculiar to himself.

The nervous system of man is particularly distinguished by the ample development of the cerebral hemispheres. The human cerebrum extends so far backwards as to cover the whole of the cerebellum; the ourang-outang's cerebrum allows the cerebellum to be seen behind it, and the otter's and sheep's do so still more decidedly. In the marmot, and other Rodentia, not only the cerebellum, but also the parts from which the optic nerves arise (optic tubercles, also called corpora quadrigemina) are partially exposed, and the convolutions on the surface of the brain have disappeared. In birds the exposure is still greater, and becomes complete in reptiles and in fishes.

FIG. 14.



The right hemisphere of the brain cut through the corpus callosum, pons Varolii, medulla oblongata, and cerebellum. M M Convolutions, flat—color, reddish grey. A, Medulla oblongata cut through the median line. Color, outer portion bluish white—inner portion, reddish grey. a Pyramidal body. B Pons Varolii, or tuber annulare. Color, white outside—inside, reddish grey. c Tubercula quadrigemina. D, Crus cerebri. E The great inferior ganglion—posterior striated body (thalamus)—color, bluish white. F The great superior ganglion—anterior striated body—color, reddish grey. G Annular ganglion. H Corpus callosum—color, bluish white. K Fissura Sylvii. L the cerebellum. e The arbor vitæ—color, white, in the reddish grey ground of the incised cerebellum. T The tentorium, separating the cerebellum from the brain. n Locus niger.

FIG. 15.



Represents the right hemisphere of the brain, in which the convolutions are cut away to the depth of about three-quarters of an inch to show the fibres radiating from the centre of the outer surface of the great inferior ganglion into the convolutions.

The white spot in the centre of the figure represents the outer surface of the great inferior ganglion over which the fibres are drawn with great accuracy from the original.

c Internal structure of the convolutions. e Fibres of the convolutions agglutinated by a very delicate neurilemma.

It was at one time thought that the brain of man was not only relatively, but absolutely, larger than that of any other animal; but it is now known that the amount of nervous matter in the elephant's brain, and in some others, is greater. Relatively, however, to the size of their bodies, the comparison is more in our favor. For example: in man, the ratio of the weight of the brain to that of the whole body is about one to 28, while in the dog it averages about 1 to 160, in the horse 1 to 400, and in the elephant 1 to 500. But again, on the other hand, it is curious to remark, that the brain of the canary bird, compared with its body, is as high as 1 to 14; and there is a species of monkey in which the proportion is even 1 to 11. For various reasons, however, comparisons of this kind are not considered as furnishing a fair estimate. Another method has been proposed by Soemmering, an eminent physiologist, to which hitherto few if any exceptions have been found, and which depends on the ratio which the size of the brain holds to the aggregate bulk of the nerves that proceed from it. As an illustration of this method, the example of the horse may be cited. The absolute size of the brain of the horse is only about half that of the human brain, while the mass of the nerves of the horse, at their origin, is no less than ten times greater than that of man.

By adopting this principle, we are able, in most instances at least, to trace a correspondence between the cerebral development and the amount of intelligence, and we pass by easy gradations, from one class of animals to another upwards to man, between whom and all the rest there exists a great gap. Between the two extremes the difference is very striking. To show this, we weighed a cod, and found it to be 27 pounds. We weighed its brain (including all the nervous matter above the medulla oblongata), and found it to be 44 grains. As a comparison we weighed a child, which died four days after birth, and found it to be seven pounds. Its brain was also weighed, and was found to be no less than 6912 grains. A similar comparison may be made with the adult brain. Mr. Scoresby found the brain of a young whale (whose body weighed 11,200 pounds) to be 3 pounds 12 ounces. The body of Byron or Cuvier would probably not weigh more than 200 pounds, and yet the brain of the former is said to have weighed $4\frac{1}{2}$ pounds, while Cuvier's brain weighed 4 pounds $13\frac{1}{2}$ ounces*—the heaviest we believe upon record.

From the great mass of nervous matter which man's brain con-

* Brigham on the Influence of Mental Cultivation on the Brain.

tains, it is necessarily a very active organ. It is to it, as the organ of the mind, that we owe our pre-eminence as moral beings, as well as all that has been accomplished in the arts, in science, and in literature. While we cannot but be gratified for what has thus been done, it must be confessed that the too great activity of this organ often leads to melancholy consequences. A large proportion of those who devote themselves to intellectual occupations, irreparably injure their health. This arises from two causes. 1st, Because these persons often do not mingle a due amount of bodily exercise with their studies. Many young students, especially, fall a sacrifice to this error. Where proper out-of-door exercise is regularly taken, we are inclined to believe that moderate study will, in most instances, be found the reverse of hurtful. But 2dly, by far the most injurious consequences follow from such engagements or studies as continually excite, and agitate, and harass the mind, and consequently the brain. The constitution must be good, indeed, in which such a course does not give rise to impaired appetite, habitually painful digestion, or some more serious disease. The brain, like every other organ, if its powers are continually put upon the stretch, almost necessarily becomes itself deranged, or deranges some other organ.*

The diseases of the brain are too numerous to allow of even a reference to them individually. The one most commonly met with in practice, is perhaps that particular species of inflammation which gives rise to hydrocephalus, or water of the head. This fatal disease occurs most commonly in childhood, and the physician can usually trace it to the variety of constitution termed the scrofulous. The tendency to it is generally derived from parents; and hence, when it has once occurred or is suspected in a family, very great attention to the general health of the other members of it is called for. Another disease of the brain, unfortunately of frequent occur-

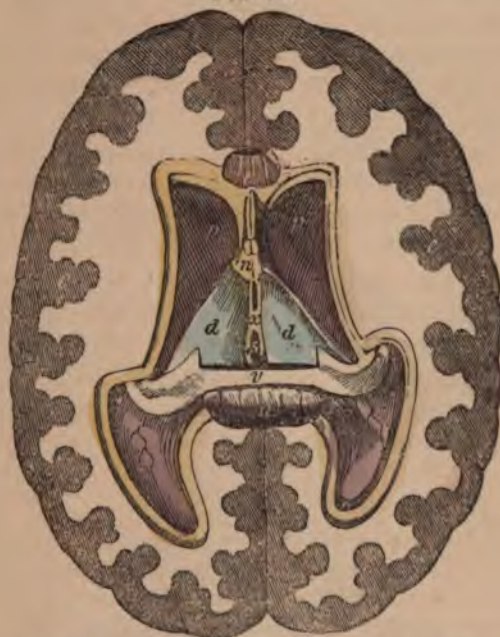
* "Every physician," says a writer, "has melancholy experience of such cases. We lately met with a painful one, which may be mentioned as an example. A young gentleman, a student of divinity, of not a very strong constitution originally, met with a favorable opening for commencing a school in April, 1837. Anxious for the success of his school, as well as for the progress of his studies, he made the harassing duties of the former the only relaxation from the latter. The consequence was, as might have been naturally anticipated, that his health sank under it, and he was obliged to give up his school in April, 1838. His health continued in the most precarious state until June, 1838, when he was seized with inflammation of the membranes of the brain, which proved fatal. After death, not only the brain, but all of the other important organs, were found in a highly diseased state."

FIG. 10. SIDE VIEW AND EXTERIOR OF THE BRAIN, CEREBELLUM, CONVOLUTIONS, AND MEDULLA OBLONGATA.

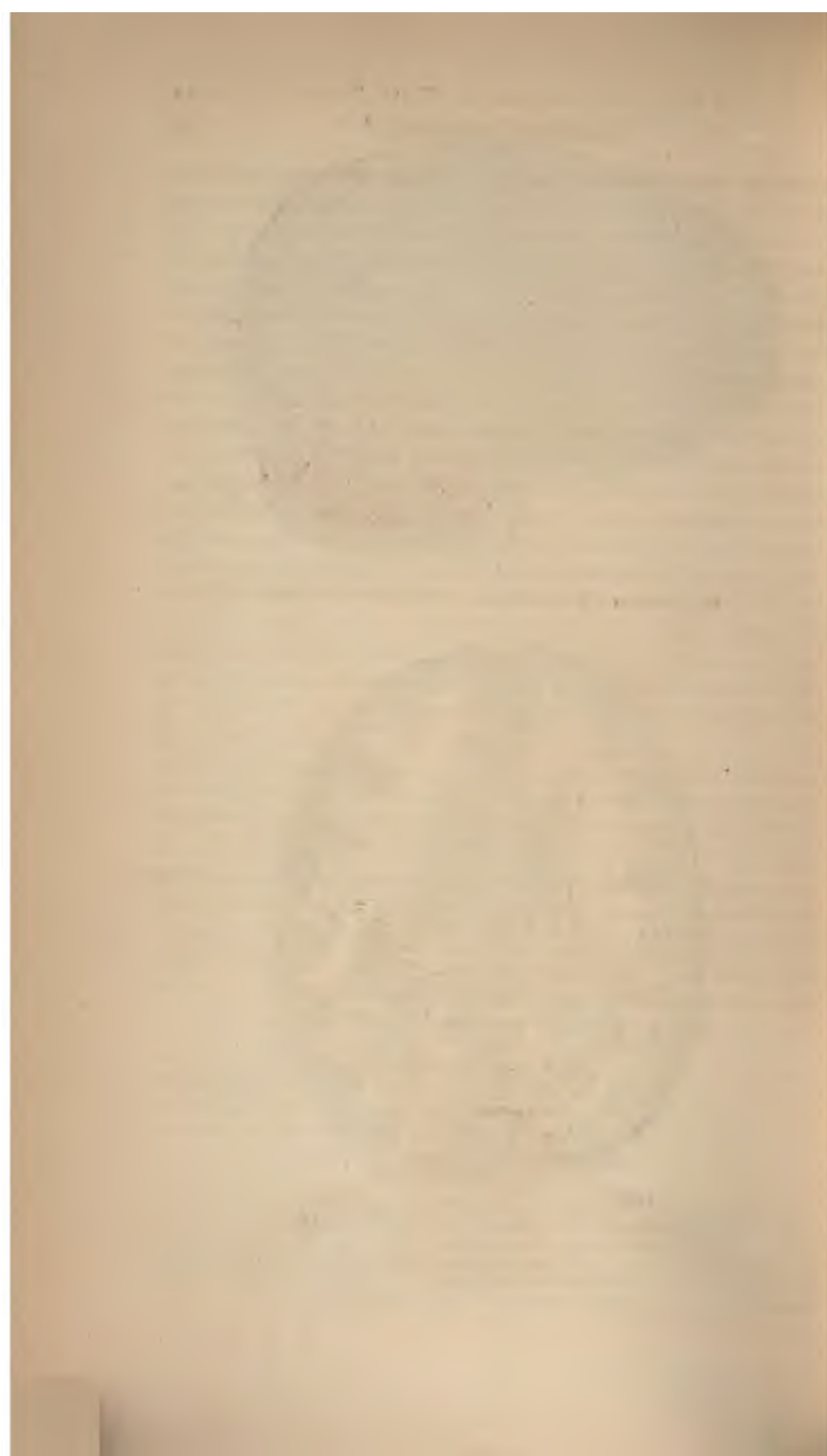


C—Cerebrum. D—Cerebellum. E—Medulla Oblongata.

FIG. 11.



A horizontal section of the brain at a depth of about an inch from its base, or under surface. *ee* Convolutions or cortical part of the Brain—color, reddish grey. *u*, Fourth ventricle. *v* Posterior commissure—color, white. *s* Third ventricle, or separation between the great ganglions. *dd* Great inferior ganglions—color, bluish white. *x* Middle commissure. *n* Anterior commissure. *pp* Great superior ganglions—striated—color, reddish grey. *t* Anterior opening into the lateral ventricles.



rence, is called *delirium tremens*. It arises from the continued abuse of ardent spirits. There are three organs especially affected by this baneful habit—the brain, the liver, and the kidneys. The two latter slowly, but surely, become diseased, and their diseases generally prove fatal. *Delirium tremens*, however, though a dangerous, is not usually a fatal disease. The person affected is in a high state of excitement, thinks he is surrounded by evil spirits, imagines all his friends are plotting against him, and a thousand other fancies. The mind, in certain other states and diseases, is also very singularly affected, which it would be curious to refer to, did our space permit. Dr. Abercrombie's work on the intellectual powers, the works of phrenologists, those on somnambulism and animal magnetism, &c., contain some very interesting facts on this subject.

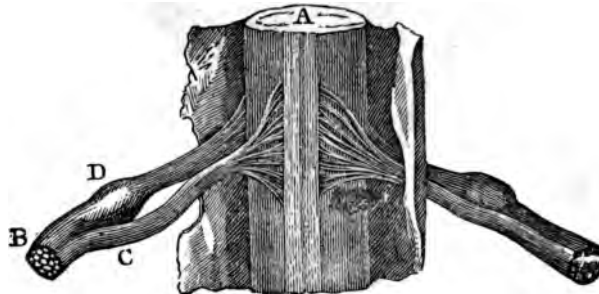
[To illustrate this section, the brain of a sheep may be exhibited, which can easily be done by sawing through the skull from behind the eyes down to the opening for the spinal marrow (taking care not to saw too deep), and then wrenching it off with a screw-driver or other strong lever. The membranes covering the brain will be observed. These should be slit open, and the brain lifted up anteriorly, when the different nerves, commencing with the olfactory, will come into view, and must be cut through, and the brain taken out and placed in spirits for a few hours to harden it. The nerves, as seen in Fig. 33, the ventricles in the interior of the brain, and the other parts described here, and in anatomical works, may then easily be seen. A cod's or haddock's brain and spinal marrow may easily be shown, by cutting with a strong pair of scissors the spinal rings and the skull.

Besides these, if wished, the progressive development of the brain in different species may, with a little care and patience, be shown in the fowl, the hare or rabbit, the adder or frog, &c.

A few casts, showing the size and appearance of the human brain, that of the orang-outang, of idiots, &c., and casts of the heads of the Carib, Negro, European, &c., form excellent illustrations of this section, and can easily be obtained.

Appropriate figures for illustrating this section will be found in Fletcher's *Rudiments of Physiology*, Part I., pages 47 and 48; in Lizars colored plates, pages 64, 67, 68; in Roget's *Bridgewater Treatise*, vol. ii. pages 547, 550, 552, &c.]

Front view of a section of the Spinal Cord, and Spinal Nerves

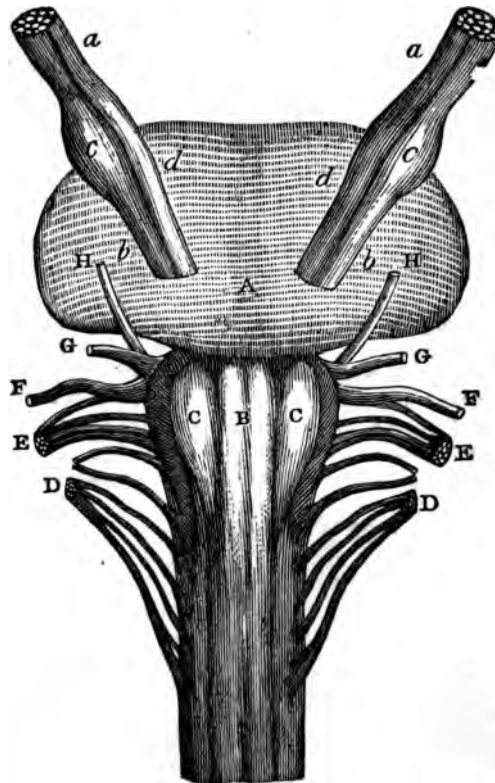


A—Spinal Cord. B—Spinal Nerve. C—Motor branch of Spinal Nerve. D—Ganglion of posterior branch of Spinal Nerve.

The order and uses of the ten pair of nerves are thus explained by a French poet :—

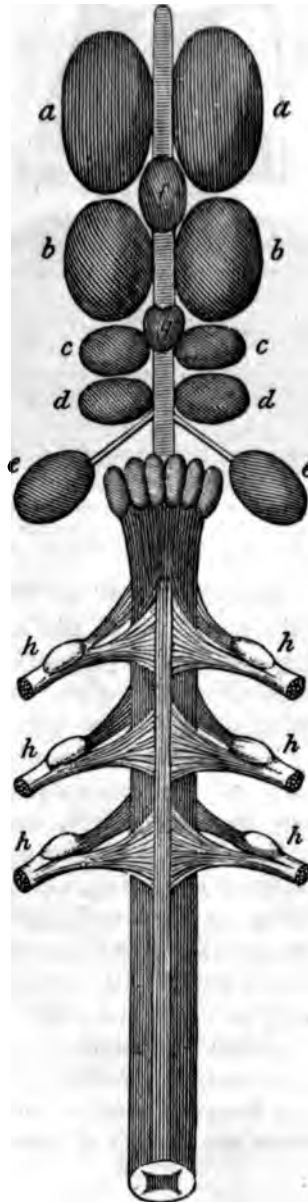
"On viewing nature's noble plan of things,
We find five senses mov'd by double strings;
While every fibre aids the lively sense,
Ordain'd by wisest laws of Providence.
The first, in rank, directs our fragrant smell;
The second gives us power of seeing well;
The third commands the motions of our sight,
To contemplate with ease the sacred light;
The fourth to secret lovers gives the law;
The fifth keeps time in moving either jaw;
The sixth, by turns, portrays our pride or sight;
The seventh asserts to melody a right;
To wake the soul with feelings fit for kings;
The eighth strong nerve employs a hundred springs;
The ninth excites the call for daily bread,
The tenth sustains with grace the neck and head."

A front view of the Medulla Oblongata, lateral nerves, Pons Varolii, and fifth pair of nerves



M—Medulla oblongata. A—Pons Varolii. B—Corpus Pyramidale. C—Corpus Olfactory. D—Spinal accessory nerve. E—Par Vagus. F—Glosso-Pharyngeal nerve. G—Portio Dura of the seventh. H—Fourth Nerve. I I—Anterior column of the Spinal Cord. a—Ganglionic branch of the fifth nerve. c—Ganglion. d—Motor branch of the fifth nerve.

View of the ganglions, brain, and spinal nerves, size, &c.



i superior ganglions—color, redish grey. *b b*, Great inferior ganglions—color, bluish. *c c*, Cerebellar ganglions—color, bluish white. *e e*, Olivary ganglions—color bluish white. *g g*, Ganglions of spinal nerves. *a a*, Pyramidal bodies—color, bluish white. *o o*, Restiform bodies—color, bluish white. *d d*, Posterior quadrigeminal bodies—color, bluish white. *c c*, Anterior geminal bodies—color, bluish white. *s*, Pineal gland—color, redish grey. *f*, Medulla—color, bluish white. *u*, Spinal cord—color, bluish white. *v*, Middle cineriferous spinal cord—color, redish grey.

The cerebellum, and its connexion with the Brain, or Cerebrum



A A, The cerebellum. B, Processus vermiculares—organ of motion. a a, The posterior corpora quadrigemina. c c, The great anterior corpora quadrigemina. d d, The great inferior ganglions. e, Pineal gland. m m, Posterior part of the great superior ganglions.

NATURE, CAUSES, AND TREATMENT OF NERVOUS DISEASES.

Having described the nerves, I will add a few remarks on the diseases to which they are liable, and there is no class of diseases more afflicting and protracted. Most of nervous complaints proceed from inveterate irritation of the sentient ends of nerves, and cause morbid influences by sympathy. The head, stomach, liver, and bowels, all reciprocally act upon each other, and the mind, being connected to the body by these nerves, becomes proportionably diseased, melancholy, depressed, if not deranged.

The treatment consists in removing, as far as possible, all exciting causes; in regulating the digestive organs by appropriate vegetable medicine, and proper diet, which should be light and nutritious. The surface of the body should be daily bathed with weak cold ley water, followed by friction. Exercise should be taken daily in the open air, in pleasant weather. Constant employment is indispensably necessary. All gloomy stories and objects to be avoided. The medicines indicated are *laxatives*, *nervines*, and *tonics*. *Mercury* to be avoided. Fowler on the subject of Nervous Diseases has the following remarks:—

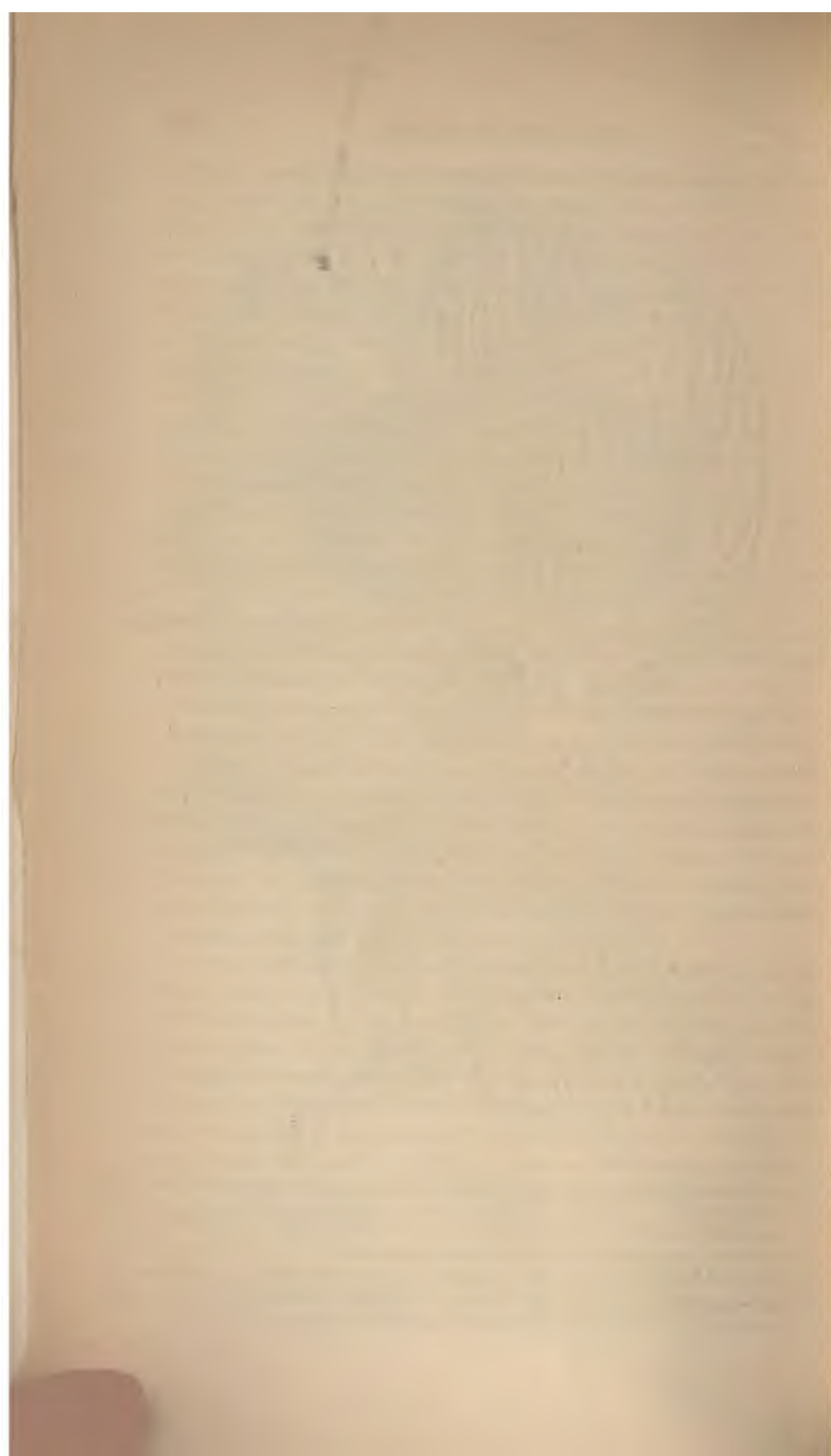
“THE CURE OF DISORDERED NERVES.

“The mental signs of nervous disease or state of feeling have already been pointed out. It remains to give a few physical in-

Fig. 23.



Series of glands along the neck with some of their satellites, together with the principal nerves of the neck and face with which they are connected. This series, with that on the left side of the neck, is continued along the whole length of the spine under the names of dorsal, lumbar, and sacral glands before noticed. On an examination of the fluid that has passed through these glands on its way to the heart, with a magnifying glass, it is found to contain a great number of minute round bodies of a white or milky color, which are accumulated in the blood and form its globules.



dices, so that those afflicted may know what ails them. Tenderness, amounting perhaps to soreness, on the top of the head just behind Veneration betokens this disease. The reason is this. As the heart, lungs, stomach, muscles, and all the internal organs have each their respective cerebral organs in the cerebellum, so the nervous system has its centre at that seat of the soul already pointed out, so that the painful state of the nerves causes pain at this their centre, and of course a tenderness at the top of the head over this seat. This shows why nervous derangement disorders all the feelings and renders all the mental operations painful. Hence nervous people can never enjoy life till they restore their nerves.

“ Besides this tenderness, nervous patients are easily agitated, flustered, and thrown into a confused state of mind by trifles, are easily elated and depressed, quick in all their movements, full of excitement, liable to wakefulness, and full of bad feelings throughout mind and body.

“ But to their cure. This disease is more frequently sympathetic than primary. Dyspepsia is always accompanied by nervousness. So are heart affections, scrofula, gout, fevers, colds, and nearly or quite all forms of disease. In fact, as the nerves are ramified throughout every organ and portion of the body, and reciprocally inter-related with every part, of course they sympathize perfectly with the healthy and diseased, active and sluggish state of the body as a whole, and of all its parts. Hence, whether nervous disorders are primary or sympathetic, the effectual means of curing them is to restore the tone and vigor of the SYSTEM AS A WHOLE, by obeying those laws of dietetics, circulation, respiration, sleep, bathing, friction, exercise, and the like, already pointed out. True, health of nerves more effectually promotes general health than perhaps all other instrumentalities. Indeed, the perfect reciprocity existing between them and the rest of the system renders it difficult to say whether remedial agents should be applied primarily to them when disordered or to the system as a whole. But this much is certain, that the promotion of general health is the great means of restoring disordered nerves. Let nervous patients then strictly fulfil all the conditions of health, if they would effect a cure. To a few items, however, special attention should be directed.

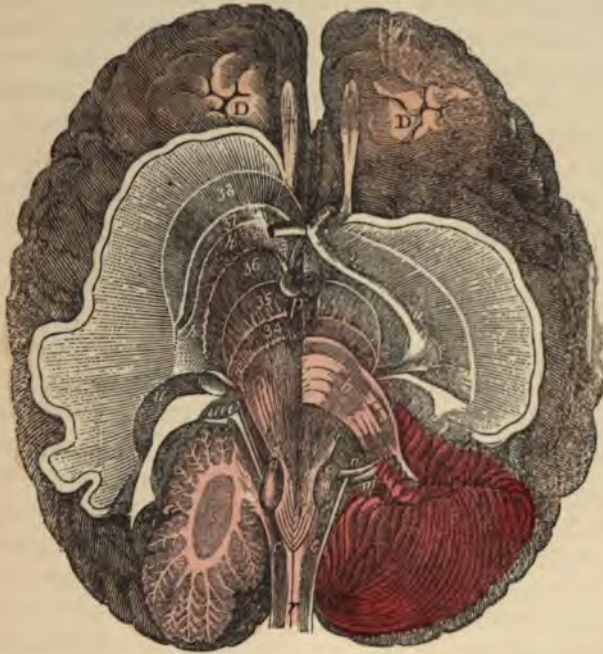
“ 1. The importance of bathing, friction, and healthy action of the skin is to such doubly enhanced, directions for which need not be repeated. The hand-bath, properly applied, will be found an almost sovereign panacea for these complaints.

"2. Those nervous subjects who are also dyspeptic need not expect to restore their nerves till they restore their stomachs. The corruption engendered by impaired digestion, is so great as to keep even healthy nerves in a perpetual fever. This irritating cause must be removed before health can be restored; directions for which will be found under dyspepsia.

"3. Nervous people are particularly troubled with restlessness. Though perpetually worn out for want of rest, they can compose themselves to sleep only with difficulty, sleep lightly, are restless, disturbed by dreams, easily wakened, and find great difficulty in again getting to sleep. Hence such should sleep **ALL THEY CAN**. No cure for nervousness at all equals sleep; nor are eight and even ten hours per diem too much for such. They sleep slowly when asleep, yet exhaust themselves rapidly while awake, and hence should devote the more time to this all-important function. Let such observe with especial assiduity the directions for promoting sleep already prescribed. To such, light suppers and as much exercise as can be well borne will be found especially important. Yet such hate to move till obliged to, and then are perpetually liable to over exertion—not to do too much absolutely, but too **FAST**, so as to induce that trembling already pointed out as a sign of this. If they would only exercise moderately, they might do a great deal more, but their nervousness renders them always in a great hurry, and hence they take hold of exercise too rashly. Such should work moderately till just comfortably tired, then rest awhile, perhaps lie down, and, if possible, take a nap, then return to work, and thus often alternate between action and rest. Day naps to the nervous will be found especially serviceable.

"4. To the influence of grief, and all kinds of sadness, melancholy, and despondency, special attention is invited. See how many tolerably healthy mothers have become nervous immediately on the death of a dearly beloved friend or child, have declined rapidly, and soon after followed their lost one to a premature grave. Those at all predisposed to nervous disorder, who may lose friends, must banish grief, and, as far as possible, not indulge it. Must their death hasten yours? If your grief could benefit their souls, indulge it; but since it injures you in the most effectual manner possible, without doing any good, practical wisdom dictates its banishment. Instead, cultivate cheerfulness and even mirth. Nothing will equally soothe irritated nerves, or tend to restore their tone and happy function.

FIG. 20.



Fibres are here seen radiating from the third ventricle or cavity *p*, into the substance of the brain, and along the medulla oblongata and spinal cord *r*, and the convolutions in the front part of the cerebrum *D D* are here seen to converge to a centre. In dissections, the radiations are also seen extending along the nerves, like those along the optic nerves seen in this figure, and from the spinal cord along the spinal nerves connected with the organs. So that the medulla oblongata, spinal cord, and spinal nerves, with those that issue from the central portions of the brain, appear like an elongation or continuation of its stria.



"5. Severe mental application is especially deleterious to nervous invalids. Their disorder consists mainly in predominant cerebral and nervous action; and their cure, in restoring the requisite balance by reducing it. Those, then, whose occupation requires much mental application, must give up their business or their happiness, if not lives. The former may be like plucking a right eye, but the latter is worse. Why prosecute business at the sacrifice of life? Do you not pursue your avocation simply as a means of enjoyment? Then why not give it up when it conflicts with this only end of life? Besides, by suspending it till restored, how much more you will be enabled to do in the long run. So that, merely for the sake of accomplishing the very business you would do, postpone it temporarily.

"What folly to sacrifice a lifetime of business to a few months, or even years! Why kill the goose that lays the golden egg? Cure your nerves first, and do your business afterwards.

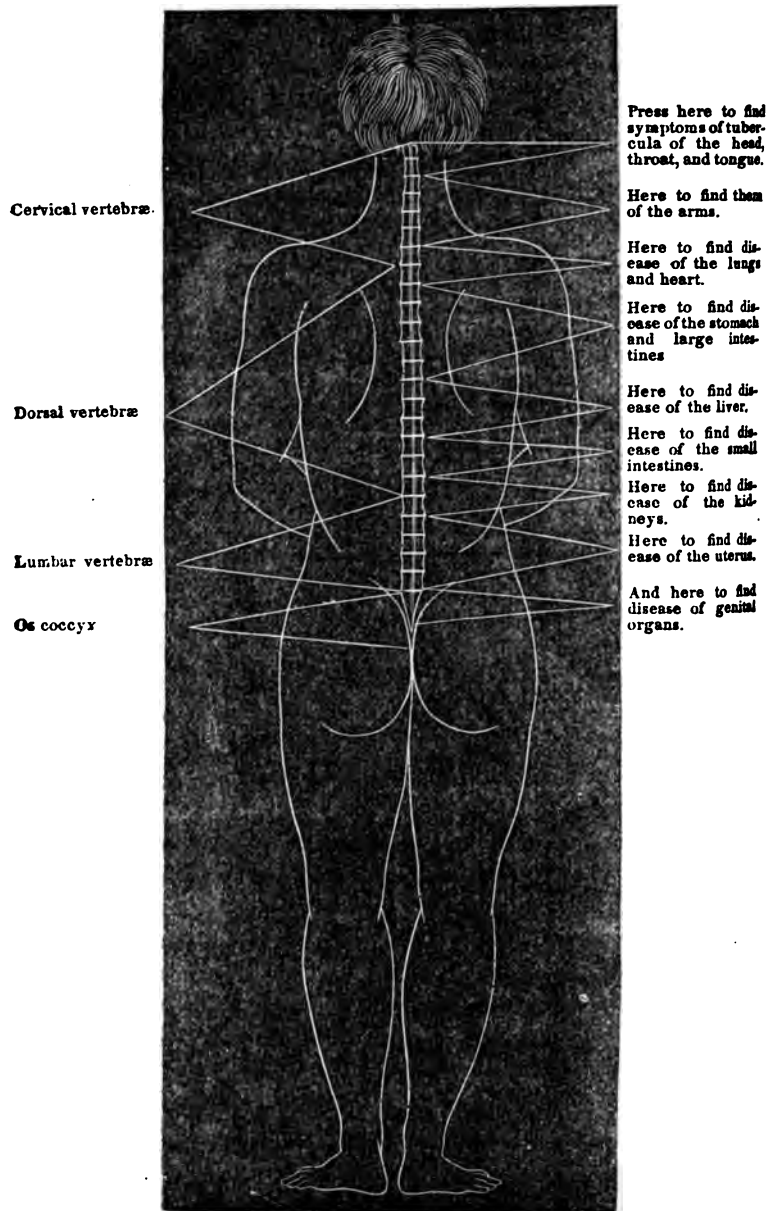
"A light, simple diet is quite as indispensable to the nervous as dyspeptic. Few things oppress the nervous more than over eating, or relieve them more than abstemiousness.

"6. But a cooling diet is even more important. All condiments, all stimulants, act mainly upon the nerves, and re-excite, and still farther disease them. Hence all alcoholic drinks, wines, beers, cider, ale, all kinds of fermented liquors are fire to them, and should be wholly avoided. Tobacco is another powerful irritant—is fatal to nervous quiet. In common with opium, it exhilarates temporarily only ultimately to fever and disorder. No higher proof of this is required than the feelings consequent on its abstinence. And the more wretched you feel when deprived of your pipe, quid, or segar, the more it has already impaired your nerves, and will increase its ravages.

"7. Tea and coffee have a similar effect. The stronger teas are rank poison to the nerves, and black teas are poisonous, though less so. Coffee is still worse. Its strong narcotic properties powerfully enhance nervous irritability, and will create, much more aggravate nervous disorder. Susceptible as my nerves are, nothing would tempt me to fever them by tea, coffee, tobacco, or alcohol, and all who do are consummately foolish, and even wicked, and sinning against their own peace."

**IMPROVED METHOD TO DISCOVER DISEASE THROUGH THE MEDIUM
OF THE NERVOUS SYSTEM.**

In concluding this chapter on the nervous system, I will give the method practised much by Dr. H. H. Sherwood, of this city, in



forming a diagnosis or opinion of disease, and which, in many obscure cases will enable or aid the physician much better to discriminate between different diseases. Some persons expect or think that a doctor must know everything, and tell their complaints perhaps without asking them a single question. This method will, in many cases, impart this secret. Generally, however, it is necessary to form our opinion by other means of investigation.

Sherwood states as follows, in a treatise called his *Motive Power*:—These forces point to the disease in every other part of the system that may be tuberculated, in the most arbitrary manner, as in these cases without any regard to the classification of nosologists, or the pedantic theories of the schools.

In *tubercula* of the stomach, and its immediate appendages, called dyspepsia, pressure between the 2d, 3d and 4th, and sometimes 5th and 6th dorsal spaces, (counting from the last or large joint of the neck,) produces pain.

In *tubercula* of the liver, called *chronic inflammation* of the liver, or *liver complaint*, pain is produced by pressing on the right side, between the 7th and 8th, and 8th and 9th dorsal spaces, and directly opposite to the lower part of the right shoulder blade.

In *tubercula* of the spleen, pain is produced by pressure on the left side of the last named, or 7th and 8th, and 8th and 9th dorsal spaces, and opposite to the lower part of the left shoulder blade.

In *tubercula* of the right kidney, pain is produced by pressure on the right side of the space between the 12th or last dorsal, and first lumbar vertebra, and in *tubercula* of the left kidney, pain is produced by pressure on the left side of the 12th dorsal and first lumbar.

In *tubercula* of the uterus, called leucorrhœa, cholrosis, amenorrhœa, and menorrhagia, pain is produced by pressure, between all the joints of the back, except the 1st and 2d.

In *tubercula* of the genital organs, pain is produced by pressure, between the 5th or last lumbar space, and the os-coxyx.

This pain, produced by pressure, is always more or less severe, in proportion to the severity of the disease. If there is but little disease, the pressure will produce but little pain; but if there is much disease, the pain will be severe.*

The disease, in whatever organ it may be, is always either *active* or *passive*, and if it is *active*, when such pressure is made, *this pain*,

* Reason, a part of greater sensibility, sympathizing with one of less.

on every repetition of the pressure, will dart into the diseased organ, with a force or violence, proportioned to the intensity of the disease.

ANOTHER BUT SIMILAR FIGURE TO LEARN DISEASE.

Acute and chronic tubercula, or inflammatory, and chronic diseases of the serous membranes, or serous surfaces of the body, organs or limbs, including the skin and fascia of the muscles, is easily and *invariably* distinguished by pain more or less severe (in proportion to the intensity of the disease), produced by pressure on the ganglions of the spinal nerves, in the intervertebral spaces along each side of the spine without any previous knowledge of the case—no matter what name may have been given to the disease by physicians, nosologists, or other medical writers.

Ganglions of the Spinal Nerves in the intervertebral spaces.



There are 7 cervical vertebrae, C ; 12 dorsal, D ; and 5 lumbar, L ; these vertebrae, with the os coccyx, m, constitute the spinal column. The spinal cord passes from the brain along the round cavity through the middle of the vertebrae, and the above ganglions are connected with it by the sympathetic nerves, which are also connected with the organs and muscles.

Press on the *sides* of the 1st cervical vertebrae to find symptoms of tubercula of the head—of the brain, throat, nose, eyes, or ears.

Press on the *sides* of the 2, 3, 4, 5, 6, and 7 cervical to find tubercula of the muscles (Rheumatism), or of the vertebrae, or of the joints of the limbs—white swellings, &c.

Press on the sides of the intervertebral space between the 7 cervical, and 1 dorsal, to find tubercula of the lungs; and

Press on the left side of the same space to find tubercula of the heart.

Press on the space between the 1 and 2 *dorsal* vertebræ to find tubercula of the stomach.

Press on the space between the 2 and 3 *dorsal* to find tubercula of the duodenum.

Press on the right side of the space between the 7 and 8 dorsal to find tubercula of the liver.

Press on the spaces between the 11 and 12 dorsal to find tubercula of the small intestines.

Press on the spaces between the 12 dorsal and first lumbar to find tubercula of the kidneys.

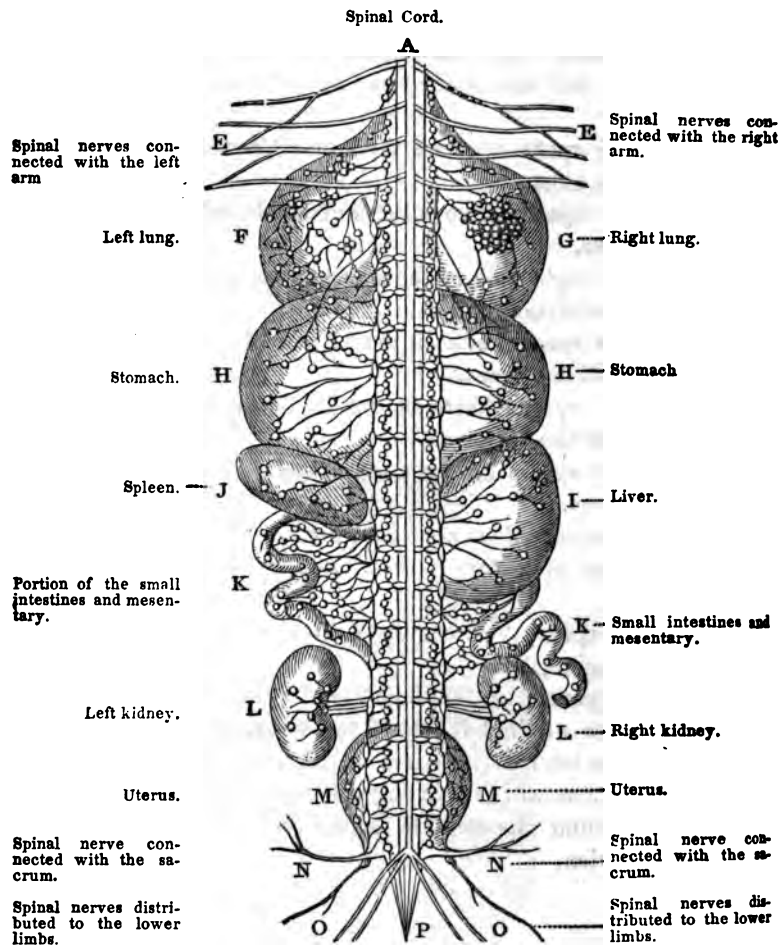
Press on the spaces between the 1 and 4 lumbar to find tubercula of the uterus.

Press on the spaces between the 4 lumbar and os coccyx to find tubercula of the ovaria, prostrate gland, vesicular seminales, and testes.

Press on the spaces between the 4 lumbar and os coccyx, to find tubercula of vagina, &c.

We always press with the thumb of the right hand on the intervertebral spaces of the left side of the spine, and with that of the left hand on the intervebral spaces of the right side.

These directions will enable any person of common sense to distinguish tubercular disease with facility and certainty, without the aid of a physician.



A. Representing a back view of the organs, cords, and connexions with the spinal and sympathetic nerves, ganglions, and gland, with tubercular diseases of these organs, as seen in clusters like grapes—F and G.

FIG. 24.



Gives a beautiful view of the grand sympathetic nerve, ganglions, and other organs of the body connected with it. Reduced from Manec's plate. This nerve has its origin in or near the brain, and is extensively distributed over various parts of the body, and accounts for the sympathy which one part has with another, though very distant.

The figures refer to the infinite number of ganglions, flexures, and branches of this great and extraordinary nerve. Sherwood says, "I have no doubt the ganglions of this nerve evolve a nervous fluid, which is magnetic, being magnetic poles or forces."



CHAPTER VII.

RESPIRATION.

STRUCTURE OF THE LUNGS—THE THORAX AND ITS CONTENTS.

THE thorax is bounded anteriorly by the sternum and cartilages of the ribs, posteriorly by the vertebræ and lesser circle of the ribs, and on either side by the shafts of the ribs and the intercostal muscles. Its upper orifice is transversely oval, and allows the exit and entrance of vessels, nerves, and muscles to and from its cavity; its inferior orifice, or circumference, being much larger, and closed by the diaphragm.

The thorax contains the heart and lungs, and also several vessels, nerves, glands, &c., to be noticed as we proceed.

THE PLEURÆ

Are two serous membranes, one on either side, which cover the inner surface of the thorax, and are reflected upon the outer surfaces of the parts contained in its cavity. That portion of the pleura which lines the thorax, is called the *parietal* layer, and that which lines the contained parts the *visceral* layer. Each pleura can be traced in the following manner:—From the posterior surface of the sternum it passes backwards until it meets with the anterior surface of the pericardium, along the side of which it passes to the anterior surface of the root of the lung; from this it passes upon the lung, and is reflected over the entire surface of the organ, until it arrives at the posterior surface of its root and of the pericardium, from whence it passes upon the sides of the bodies of the vertebræ, reaching as high as the transverse process of the sixth cervical vertebra on the right side, the seventh on the left, and descending to the diaphragm, the thoracic aspect of which it covers; it finally lines the ribs and intercostal muscles, until it arrives at the portion which was opened, and which corresponds to the posterior aspect of the sternum.

Ligamentum latum pulmonis (one on either side) is merely a triangular fold of pleura, formed by the reflection of the membrane from the lower edge of the root of the lung upon the diaphragm.

ANTERIOR MEDIASTINUM,

A triangular cavity formed by tearing through the cellular tissue, which connects the right and left pleura behind the sternum; the base is formed by the sternum, the sides by the separated pleura, and the apex corresponds to the anterior surface of the pericardium, where the pleuræ separate to enclose this bag. Thus formed, it contains the origins of the sterno-hyoid and sterno-thyroid muscles, branches of the descendens noni nerve, the remains of the thymus gland, lymphatic glands and absorbents, the mammary vessels, the triangulare sterni muscles, and loose cellular tissue.

MIDDLE MEDIASTINUM

Is of an oval shape, and is formed by the reflection of the pleuræ upon the sides of the pericardium; it consequently contains this bag and its contents.

POSTERIOR MEDIASTINUM

Is formed by the reflection of the pleuræ upon the sides of the bodies of the vertebræ; it is of a triangular form, the apex anterior corresponding to the posterior surface of the pericardium, the sides formed by the pleuræ, and the base represented by the anterior surfaces of the bodies of the vertebræ; it extends from the third to the tenth dorsal vertebra, and contains the following parts:—the bifurcation of the trachea, the œsophagus, and pneumo-gastric nerves, the thoracic duct, the vena azygos, the thoracic aorta, the splanchnic nerves, lymphatic glands, absorbents, and loose cellular tissue.

THE LUNGS

Are two soft, spongy, vascular bodies, one contained on each side of the cavity of the chest. Each lung resembles a cone, with that side corresponding to the median line truncated; the base concave, corresponds to the diaphragm, the obtuse rounded apex rises in the neck, a little above the level of the first rib; the external convex surface corresponds to the internal concave surface of the thoracic parietes, and the flat or truncated surface corresponds to the mediastina. The posterior edge of the lung is thick and rounded, whilst the anterior is thin and irregular. Each lung is distinguished into lobes, which are separated from each other by fissures; a little above the centre of each is the *root* formed by the pulmonary ves-

sels and bronchial tube, connected to each other by cellular tissue, and invested by the pleura. The bronchial tube is situated posterior and superior to the pulmonary vessels; the two pulmonary veins are placed anterior and inferior to the artery and bronchus, and the pulmonary artery is placed between the bronchus and the pulmonary veins, but behind the pulmonary veins and before the bronchus. The *root* of each lung has anterior to it the phrenic nerve and filaments of the pneumo-gastric nerve; posterior to it the pulmonic plexus, and inferior the ligamentum latum. The root of the right lung has the vena azygos arching over it.

The right and left lungs differ from each other in some important particulars: the right lung is broader and shorter than the left, and consists of three lobes, separated by two fissures; the right also ascends higher in the neck, and the anterior edge of the left presents a notch where it corresponds to the apex of the heart.

The intimate structure of the lungs consists of the ultimate ramifications of the bronchial tubes, which are the continuations of the trachea, and the branches of the pulmonary artery and veins; they also receive bronchial arteries for their nutrition.

TRACHEA AND ITS RAMIFICATIONS.

The wind-pipe, or trachea, is a cylindrical tube, extending from the *crycoid* cartilage of the larynx to the level of the third dorsal vertebra. It consists of from seventeen to twenty fibro-cartilaginous rings, truncated behind, and connected to each other by an elastic membrane; about the posterior fourth of each ring is deficient, and its place is supplied by fibrous membrane.

Opposite the third dorsal vertebra the trachea divides into the right and left bronchial tubes; the right bronchus is larger than the left, and runs transversely into the root of the lung and divides into three branches; the left bronchus passes through the arch of the aorta to the root of the left lung, and divides into two branches.

The bronchi consist of cartilaginous rings, but as these tubes advance into the substance of the lung, they diminish in size and firmness, until their place is supplied by fibrous tissue, or transverse circular fibres, which tissue also disappears, and at length nothing remains but the mucous membrane, which terminates in the air-cells, upon which ramify the ultimate ramifications of the pulmonary artery and the commencing radicles of the pulmonary veins.

The ramifications of the pulmonary artery communicate with those of the pulmonary veins, beneath the mucous membrane of the

air-cells, and are enveloped in fine cellular tissue ; and except this cellular tissue, the lung has no proper parenchyma, its structure being entirely filamento-vascular. The lungs are supplied with blood by the *bronchial arteries*, derived from the thoracic aorta ; these vessels run along the bronchial tubes, subdivide as they proceed, and form a minute net-work on the attached surface of the bronchial mucous membrane ; the blood they convey to the lungs is returned to the *vena azygos*, or superior cava. The nerves distributed to the lungs are derived from the eighth pair, and a few filaments from the sympathetic.

We have now to consider the changes the blood undergoes in its course to and through the lungs. It will be recollected that the left side of the heart sends the blood into the general system ; this is called the *systemic circulation*. The right side of the heart sends it into the lungs, and this has received the name of the *pulmonic circulation*. But if the blood that goes to the lungs were received in the same state as it is sent, death would be the consequence, for venous blood is poison to the body ; and this is the reason why an animal dies when the air is prevented from getting into its windpipe by hanging or drowning. Bichat showed this very decisively. He connected, by a tube, the jugular vein of one dog with the carotid artery (which sends the blood to the brain) of another, and allowed the venous blood to flow into it. The immediate effect of this was, that the dog in whose brain the venous blood was made to circulate, became completely insensible, and would in a short time have died. On allowing the arterial blood, however, again to circulate in its brain, the dog was quickly restored.

What are the changes, then, that take place in the lungs, and how are these changes effected ? The lungs, then (vulgarly called *lights*), are principally composed, 1st, of air-tubes (bronchi), of which the windpipe (trachea) is the commencement, and which divide and subdivide until they terminate in very minute bags or air-vesicles ; and, 2dly, of the branches of the pulmonary artery which branch out upon the sides of these air-tubes. The annexed plate shows the windpipe, with the lungs entire on one side, and with the branches of the air-tubes dissected on the other. These tubes terminate in vesicles, which are said to vary in size from the fiftieth to the one hundredth part of an inch in diameter.

FIG. 27. THE RIGHT LUNG, AND AIR-PASSAGES OF THE LEFT LUNG.



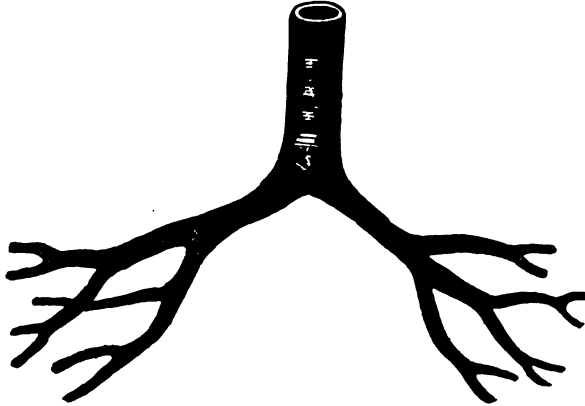
a The trachea or windpipe. *b* Bronchial tubes. *c c c* Three lobes of the right lung. *d* The inferior or concave surface of the right lung. *e e e* Air-passages of the left lung, or division and subdivision of the bronchial tubes.

FIG. 28. THE HEART AND ITS BLOOD-VESSELS.



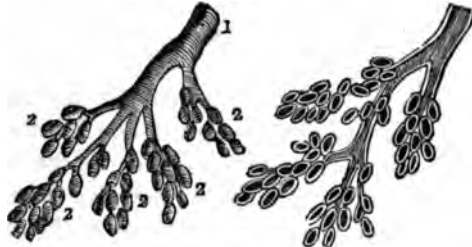


Figure 1.



Represents the Trachea, or windpipe, its bifurcation or division into two great branches, called bronchial tubes or pipes (the seat of BRONCHITIS). They again divide into numerous branches, too small to be seen with the naked eye, and terminate in a multiplicity of cells, which at every inspiration are filled with atmospheric air, which comes in contact with venous or impure blood, and changes it from a dark state to a bright, healthy vermillion or red color, and then is transmitted back to the heart.

Figure 2.



Represents the vesicles or air bladders, the first round and natural ; the second, dissected or open.

If we tie up tightly in a bladder a quantity of venous or dark blood, we shall find, in a short time, that exposure to the air has changed the color of the portion near the surface. The air has passed through the bladder, and has converted the venous into red or arterial blood. Exactly the same thing takes place in the lungs ; for the air, in the air-vesicles, is separated from the blood in its vessels by a membrane not more than the thousandth part of an inch in thickness. But we shall find, immediately, that it is not the blood alone that is altered in its qualities. The air also undergoes alterations. The blood in the lungs becomes fit for supporting life ; the air becomes unfit for this purpose. We must, therefore, describe, 1st, the means by which the air is brought into, and then removed from, the lungs ; and, 2dly, the changes of composition that thence occur in the air and in the blood.

The lungs, then, are contained in the chest or thorax, a conical cavity formed by the sternum or breast-bone before, the back-bone behind, and the ribs above and on the sides. It is separated inferiorly from the abdomen or belly by a fleshy movable partition called the *diaphragm*, which is fixed to the bottom of the breast-bone and edges of the short ribs before, and extends downwards and backwards to be attached also to the spine behind. Through this the œsophagus or gullet, blood-vessels, &c., pass. The whole inside of the chest is lined by a thin smooth membrane called the *pleura*, which divides the chest into a right and a left side, and which likewise covers the lungs; but these are, nevertheless, on the outside of the pleura, in the same way as the head is on the outside of the double nightcap. There is no opening to admit the air between the lungs and sides of the chest, but it gets in easily by the windpipe into the air-tubes of the lungs.

From these explanations it will be easy to understand the mechanism of *respiration* (breathing). Drawing in a breath is called *inspiration*. We do this, 1st, by raising the ribs, which are provided with numerous muscles for this purpose between the ribs, and attached to the ribs and neck; and, 2dly, and at the same time, by depressing the diaphragm. Of the latter movement we become sensible, by placing the hand on the abdomen during inspiration, when we notice the ribs raised, and find the belly pushed outwards at the same moment by the descent of the diaphragm. It is, therefore, evident that the cavity of the chest must be considerably enlarged by inspiration. But the cavity of the chest cannot be enlarged without something filling it up; and as no air can get between the lungs and sides of the chest, if the windpipe remain open, the air necessarily rushes by it into the air-tubes and vesicles of the lungs, and blows them up as we might blow up a bladder. The expulsion of the air from the lungs is effected principally by the elasticity of the ribs, and by the contraction of the muscles of the belly pushing up the diaphragm. It is called *expiration*.

It must be manifest, from considering these arrangements, that the amount of blood and air brought together in the lungs must be very great. The whole extent of the air-tubes, in man, taken collectively, has been calculated by Hales at about twenty thousand square inches, and by Monro at twenty times the surface of the human body; the branches of the pulmonary artery, which ramify upon this surface, are so twined and interlaced, that they have re-

ceived the name, from anatomists, of *the wonderful net-work* ; while the air received into and expelled from the lungs, and consequently brought into contact with its air-tubes and blood-vessels, cannot be less, in an ordinary man, than between three and four thousand gallons daily.

Fresh supplies of air, then, that the blood may be purified, are the essential objects of a respiratory apparatus ; and from the necessity of having some modification of such an apparatus, no animal whatever is exempted, although the supply of air required varies much. A frog or lizard, for example, will live a considerable time in air which a bird has been forced to breathe till it has died, and insects will live for a long period even in the air that has ceased to support both the bird and the lizard. Fishes, again, whose gills perform the same office as our lungs, can exist upon the small portion of air they extract from the water in which they swim. But, however small the quantity required, none can want it altogether ; and if any of them be placed under the receiver of an air-pump, and the air be exhausted, they immediately become distressed, and die in a short time.

There is one remarkable circumstance that may be noted when the motions of the heart, or intestines, and those of respiration, are contrasted. The motions of the former are entirely removed from the influence of the will, and usually do not excite in us any consciousness of their existence ; while those of respiration are always preceded by a sensation, if not also by an act, of volition. Before the air is drawn into the chest, we have always a peculiar sensation, reminding us that a fresh supply of this material is required. At first, this sensation is merely a gentle intimation ; but, if neglected, it becomes so intolerably painful, as to compel us to relieve it by breathing. When an individual becomes partly insensible, the sensation requires to be considerable before he attends to it ; and accordingly we find, that, instead of breathing, as we ordinarily do, fifteen or twenty times in a minute, he will breathe only once in half a minute. When insensibility increases still further, this and all other feelings become extinct, and then he dies. It is upon this principle we give an explanation of sighing. When a person sighs, the mind has been intensely fixed on some object. The consequence is, as Dr. Darwin has remarked, that he forgets for a short time to breathe, until the sensation in the chest becomes so importunate as to oblige him to make a more than usually full inspiration to relieve it.

The mechanism of respiration is considerably modified in other classes. Whales (which breathe air) have parts that are thought to serve as reservoirs, both of venous and arterial blood; and this is conjectured to be the reason why they are able usually to remain under water twenty minutes, and sometimes upwards of an hour, without breathing. The lungs of birds, instead of being free in the chest, are fixed to its sides, and also have openings in them which allow the air to pass into air-cells that pervade almost every part of their bodies. As a proof of this, if the windpipe of an eagle be tied, and the largest bone of its wing (humerus) be broken, it can breathe through the broken bone instead of its windpipe. It is this arrangement that causes the respiration of birds to be called double, for the air acts on the blood, 1st, in passing through the lungs to the air-cells; 2dly, in passing out of these, and probably also while it remains in the air-cells. Hence, they consume more air than any other class of animals.

Reptiles can act but imperfectly on the air, from the cells of their lungs being very large, and from this cause of course diminishing the surface upon which the blood-vessels have to be distributed. The frog has no ribs, nor has it any diaphragm, the abdomen and chest forming but one cavity. As a substitute for these, the air is forced into the lungs by a species of deglutition. A frog perishes if its mouth is kept open, because, before this deglutition can be accomplished, the mouth must be closed.

The surface occupied by the gills of fishes is often very considerable. Those of one kind are said to have a surface nearly equal to that of the human body. The reason why air cannot usually be directly breathed by gills, is believed to be principally because they become collapsed and dry. The eel, the crab, and some other species, that breathe by gills, can, however, breathe in air for a considerable time.

The only other modification of the respiratory apparatus we shall refer to, is that of insects. The veined appearance of the wings of the butterfly is produced by what are called tracheæ, that have openings on the surface (stigmata) for admitting the air, and extensive ramifications over the body. There are similar openings on the side of the bee-worm and in other species. If these are closed, the animal immediately dies. In all the lowest classes of animals, and even as high as the class of reptiles, the skin is also an active respiratory organ.

What has been said may render intelligible the mechanism by

which the air is introduced into the body. It will now be necessary to describe the changes that take place there. The atmospheric air, when it goes into the lungs, is composed of about four parts of a gas called nitrogen, and one part of another gas called oxygen, (a small quantity of carbonic acid in the air). But the air which comes out from the lungs is not the same in composition, for a considerable quantity of oxygen is found to have disappeared, and in its stead we find another gas, called carbonic acid, which is produced by the union of a portion of oxygen with the carbon which forms a large ingredient in the composition of the blood and of the body in general. Carbonic acid is a gas which is fatal to animal life, and it is therefore discharged from the lungs. If an animal is made to inhale it, insensibility and death follow in a very few minutes. We have already seen that the venous blood is equally a poison to the animal body, and it is this same carbon, or charcoal, that makes it noxious. It appears that about forty-five thousand cubic inches of oxygen are consumed by an ordinary man in twenty-four hours, and that forty thousand inches of this gas go to form the carbonic acid produced during the same period, the remainder of the oxygen probably combining with other ingredients of the blood. This union causes animal heat similar to the burning of fuel. If so the lungs and arteries are a fire-place or stove which constantly generate heat. Under different circumstances, however, the consumption of oxygen varies. It is considerably greater when the temperature is low than when it is high, and during digestion the consumption has been found one-half greater than when the stomach is empty. By violent exercise, when the stomach is empty, it has been found to be augmented to three times its usual quantity, and to four times its usual quantity when food has been taken after this.

When we thus see the great quantity of pure atmospheric air which a single individual requires to carry off the noxious parts of the venous blood, and to convert this into arterial blood, we can easily comprehend why such dreadful consequences should follow the breathing of a highly vitiated atmosphere. The most melancholy instance of this kind on record, is the well-known one that occurred in the Black Hole at Calcutta. In this dungeon, eighteen feet square, and having only two small windows on the same side to admit air, one hundred and forty-six men were immured. In six hours ninety-six of them had died from suffocation, after the most horrible sufferings; and in the morning, when the

doors were opened, only twenty-three out of the whole number remained alive.

From the same cause we can understand how injurious it must be continually to breathe the air of ill-ventilated rooms, confined sleeping apartments, crowded low-roofed schools, or other places in which numbers are assembled together, and where ventilation is not particularly attended to. A long continued and constant residence in such places most certainly shortens life by several years, and not unfrequently terminates it rapidly by giving rise to fatal disorders.

It must not be supposed, however, from what has been said, that the carbon separated at the lungs is to be viewed as a merely noxious material. If it were retained, death would undoubtedly take place; but if we had no carbon to separate we shall find that the heat of our bodies could probably not be maintained. When charcoal is burned in atmospheric air, the changes which occur seem to be almost precisely similar to those that are produced by respiration. Oxygen disappears, and carbonic acid is formed. It seems reasonable, therefore, to conclude, that the heat produced in both cases is connected with these changes. That the production of animal heat bears some resemblance to combustion, is rendered probable by the following considerations:—1st, It has been determined by experiment that the charcoal contained in the carbonic acid formed during a given period by respiration, would give out, when burned, fully more than half the heat produced by the animal in that period. It takes no less than about eleven ounces of carbon to form the carbonic acid of an ordinary man's daily respiration. Dr. Milne Edwards thinks that this, and the superabundant oxygen which is absorbed by the blood (which probably combines in great part with hydrogen to form water), will account for nine-tenths of the heat an animal produces, the remaining tenth probably being the product of the friction of the different parts of the body, the changes occurring in secretion, &c. 2dly, This view is supported by the fact, that the temperature, in the different classes of animals, accurately corresponds to the quantity of oxygen consumed. The temperature of birds is highest, and they consume most. The ~~among~~ the Mammalia, consume the least, and have the ~~as lowest~~. Indeed, it may be remarked, that the young the Mammalia, including children, have much difficulty to ~~at any~~ degree of cold when separated from their ~~where~~ incunition exposure takes place, the mortality

among them is found to be very great. Reptiles, which consume little oxygen, have a temperature only a few degrees above the medium in which they live, and the same may be said of fishes, with the remarkable exception of the Cetacea (whale, porpoise, &c.) which have a high temperature, but consume much oxygen, as they breathe air by lungs.

But it may be said, if the heat of the body is produced chiefly by respiration, why have the lungs not the temperature of a furnace? Several reasons may be assigned why this should not be so; and, 1st, it must be recollected, that, even though a considerable portion of heat may be supposed to be produced in the lungs, there is also a constant and most rapid influx of *cold* blood, from the exposed parts of the body, into these, to carry off the heat as soon as it is generated.* Besides, it appears pretty certain that the blood coming from the lungs is really a degree or two hotter than in other parts of the body. 2dly, Dr. Crawford in his celebrated *Theory of Animal Heat*, has very ingeniously attempted to obviate this difficulty by maintaining that the capacity for heat (as chemists call it) is greater in arterial than in venous blood; that as this enlargement of capacity takes place at the same moment, and in the same place, as the heat is generated, a considerable portion of it must be absorbed; and that this latent heat comes to be given out as the arterial, in its course, is again gradually converted into venous blood.

The correctness of Dr. Crawford's theory has been doubted by many physiologists, on the ground, 1st, that other chemists have not found the capacities of arterial and venous blood to correspond with his statements; and, 2d, that it has been, since his time, rendered highly probable, by the experiments of Dr. Edwards and others, that a considerable portion, at least, of the carbonic acid produced by respiration, is formed, not in the lungs, but by the blood in its course, and is merely separated or given off at the lungs. Still, many of the most eminent physiologists consider modifications of Dr. Crawford's theory as affording the best explana-

* An experiment of Mr. Hunter's shows the influence of the circulation in keeping down temperature. A living part (with blood circulating through it, probably near 98 degrees) was placed in water at 118 degrees, and had its temperature elevated to 102½ degrees, that is, only 3 or 4 degrees above the natural temperature of some parts of the body; while a dead part, under the same circumstance, rose to 114 degrees, or about 12 degrees higher. Mr. Hunter imputed this difference to the influence of the vital principle, but our friend Dr. Holland has probably given a more correct explanation, in referring it to the comparatively colder fluid that circulated in the living part.

tion of the phenomena of animal heat that we at present possess. One modification of this theory we may here state. It has been supposed that the oxygen, when it is absorbed by the blood in the lungs, exists there only in a loose state of combination ; that as it circulates, the union with the carbon, &c., of the blood, becomes more intimate ; and that the heat comes thus to be gradually disengaged, and diffused through every part of the body. For further information on this subject we must refer to the works of Drs. Smith, Alison, Bostock, &c. ; but we must not omit to mention that man ; facts, which our limits will not allow us to state, prove decisively that the nervous system is connected, directly or indirectly, with the production of animal heat. We can only state generally, also, that the body possesses the power of keeping down its heat to nearly the natural standard, even when exposed to a very high temperature. Sir Charles Blagden remained, without any great inconvenience, in a room, the temperature of which was fifty-two degrees above that of boiling water, until eggs were roasted hard, and a beefsteak made ready by blowing air on it.* Indeed, the heat of his body, though the temperature of the apartment was 264 degrees, rose only three or four degrees above ninety-eight degrees, its natural standard. It has been found that the principal agent in keeping down the temperature, is the immense evaporation that takes place from the lungs and skin. Accordingly when the skin is varnished, or the air of the apartment is saturated with moisture, so as to prevent evaporation, a temperature one-half so high can hardly be borne.

Having now given a short but connected account of the physiology of respiration, we cannot but remark how varied and how complicated are the agents employed, and yet how accurately each of these performs the part assigned it. Such investigations as those with which we have been occupied, form the proper foundations of natural religion. No one can rise from the study of these parts of the animal frame, without intensely feeling that *design*, and design of a kind the most exquisite, guides every motion and change of the vital fluid. Never did any piece of machinery invented by man, indicate with greater precision the intentions of its maker.

The voice is produced in what is called the larynx, at the top of the windpipe. The air, in passing through its opening (*glottis*), causes parts called vocal ligaments to vibrate, and to give out the different varieties of sound. These sounds can be further modified

* Dr. Chaubert, of this city, a few years ago practised the same experiment.

by the parts in the mouth, &c., so as to produce articulate speech. Singing-birds have a simple larynx at the top, and a complicated one at the bottom of the windpipe.

DISEASES.

When foreign bodies, such as cherry or plum stones, get into the larynx or windpipe, they cause excessive irritation, and not unfrequently death. A few years ago, a child swallowed a clasp, one half entered the windpipe, the other the gullet. When I attended the medical lectures in the old Barclay street Medical University, this specimen, preserved in spirits, was exhibited to our class. The professor stated that the foreign body might have easily been removed had any one present possessed a little anatomical knowledge.

Affections of the top of the windpipe produces suffocation, and, among these, by far the most common and fatal, is *croup*. This disease consists in inflammation and swelling of the inner or mucous lining of the larynx and windpipe.

When the inner or mucous membrane of a few of the larger branches of the windpipe is slightly inflamed, it is called a *common cold*; when the inflammation is greater and extends to the lesser air-tubes (bronchi), it is called *bronchitis*, and is often denoted by considerable wheezing in the breathing;* when the air-vesicles, and the substance which connects them, become inflamed, it is called inflammation of the lungs (*pneumonia*). The last is a very fatal disease, if not early checked. The importance of early attention to it will be understood from this, that it consists of three stages, in the first of which the part of the lungs affected is merely engorged with the watery serum of the blood. A free perspiration will frequently remove this. But if allowed to remain, this rapidly passes into the second stage, in which the lung becomes solid, like a piece of liver (*hepatization*), and ultimately into the third stage, when the solid portion is infiltrated with matter (*pus*). The two latter stages are comparatively seldom recovered from.

When the membrane (pleura) covering the lungs and lining the

* Millers, masons, sawyers, grinders, and others who are exposed to the inhalations of various kinds of dust, are very subject to this disease, and have their lives much shortened by it. Dry grinders seldom live beyond 30 or 35 years. In M. Lombard's returns for Geneva, the average longevity of stone-cutters is stated at 34 years, of sculptors at 36 years, and of millers at 42 years; while painters live, on an average, to 44, joiners to 49, butchers 53, writers to 51, surgeons to 54, masons to 55, gardeners to 60, merchants to 62, preachers to 63, and magistrates to 69 years.

inside of the chest is inflamed, it is called *pleurisy* or *pleuritis*, and is denoted by the sharp cutting pain which is felt when we draw a breath. If uncombined with pleuritis, the pain in pneumonia (inflammation of the lungs) is not great. It is rather tightness of the chest, and oppression of the breathing, that are felt. These are caused by the difficulty the air finds in getting admission into the condensed air-vesicles. From the same cause, pneumonia is generally attended by rapid heaving and breathing. As the quantity of air that can be brought into contact with the blood is diminished, fuller and more frequent inspirations require to be made. If the hepatization extends to the whole of one lung, then there can be no motion of the chest on that side, as the air enters only to the other lung. These signs are of special importance in children. Whenever the breathing of a previously healthy child becomes rapid and heaving, alarm should be felt for its safety.

The branches of the windpipe have another coat below the inner or mucous one, which, like that of the intestines, is muscular, and can, it is thought, contract and diminish their size. This contraction is supposed to be the cause of the sudden difficulty in breathing, so often felt by asthmatic persons. In asthma, however, other causes combine to produce this difficulty; for, 1st, there is generally more or less habitual inflammation of the larger air-tubes; and, 2dly, from the repeated violent fits of coughing, the air-vesicles become distended or ruptured, so that the cavity of the chest is permanently filled to a considerable extent with these distended vesicles (*bullæ*). The surface of the lungs of old asthmatic persons may be seen studded with these, like little bladders, sometimes as large as walnuts.

The only other disease of the lungs we shall notice, is the almost invariably fatal one, consumption (*phthisis pulmonalis*). This disease consists in the formation, in the lungs, of a peculiar substance called tubercle. Tubercles are at first small semi-transparent bodies, like pins'-heads; but as they increase in size and number, they unite, and form masses generally like yellowish cheese, occasionally as large as a walnut or an orange. At a later period, this cheesy matter becomes softened, and is coughed up, leaving cavities in the lungs more or less extensive, under the irritation of which the patient sinks. Consumption, from very accurate calculations, is known to cause about one in every four deaths in England and North America, so that some knowledge of the causes which produce it, is important to almost every one. From extensive statistical

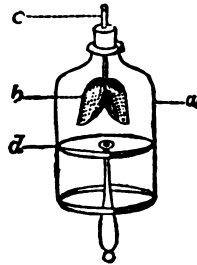
inquiries made in Geneva by Dr. Lombard, he has found that the average number of consumptive cases occurring in all the different professions of that town, is 114 in the 1000. In some it rises much above, while in others it falls greatly below, this average number. Thus, among varnish-painters no less than 37 out of the 100 were found to have died of this complaint, while of gardeners only 4 in the 100 fell a sacrifice to it. The causes which principally tend to produce consumption, Dr. Lombard finds, are, 1st, breathing air in which mineral, vegetable, or animal powders are floating: among polishers, sculptors, stone-cutters, plasterers, watch-hand-makers, &c., the proportion of consumptive complaints is 177 in the 1000. 2d, Sedentary occupations seem to have a great effect in producing this disease, the mortality among clerks, printers, tailors, engravers, &c., being 141 in the 1000; while among such active professions as carpenters, blacksmiths, slaters, agriculturists, &c., the average proportion is 89 in the 1000. 3d, Indigent persons seem about twice more liable to consumption than those living in easy circumstances: annuitants in Geneva, who may be reckoned as generally leading an easy, comfortable life, average only 50 consumptive persons in the 1000. 4th, The more or less impure state of the air breathed, its temperature, dryness, &c., seem to influence considerably the production of consumption. In professions in which life is spent in shops or manufactories, the proportion of cases is 138 in the 1000; while in those professions in which life is spent principally in the open air, only 73 in the 1000 become its victims. An atmosphere loaded with animal emanations, such as is breathed by butchers, tanners, candlemakers, &c., seems to act rather as a preventive to this complaint, the average among these professions being only 60 in the 1000. Breathing a moist air seems also a preventive circumstance, as weavers, dyers, bleachers, watermen, &c., are found liable to it only in the proportion of 53 in the 1000; while those who breathe a hot dry air, such as toolmakers, enamellers, file-smiths, &c., have 127 in the 1000 affected. These deductions may be considered as, at least, approximations to the truth, and they in general agree with what might have been expected, as we know that even in the lower animals consumption can be produced at pleasure by general debilitating causes, or by irritants applied directly to the lungs. A large proportion of the monkeys brought from their own warm to this cold and changeable climate, die of this scourge of our race; and M. Flourens, a French physiologist, has shown, that by keeping

chickens in a dark and damp cellar, and upon a scanty diet, they are rapidly carried off by this affection. Though the lungs are the parts most usually affected by this disease, it is a mistake to suppose that it is a merely local complaint. Very commonly, the cheesy matter is found, at the same time, in the liver, mesentery, and many other parts; and there can be little doubt that the essential cause of the whole is a particular form of constitution, either inherent from parents, or brought on by irregular habits, want of fresh air and exercise, or other diseases and circumstances that enfeeble the body. Where the predisposition to this disease is very great, we see whole families cut off by it; but when the predisposition is less, we often notice only those affected that follow occupations, or have contracted habits, that impair their health.* The woeful system of quackery pursued by our popular doctors, consisting of *bleeding* and *mercury*, is another fruitful source of pulmonary diseases.

The mechanism of respiration may be beautifully seen in the rabbit. After skinning, &c., open the belly, take out the intestines, liver, &c., and cut through the spine high up with a strong knife. The diaphragm, separating the belly from the chest, will then be seen. To show the parts contained in the chest, next take away the fore-legs, and cautiously detach the ribs from the breast-bone, on each side, except at the top and bottom, breaking or cut-

* We have said that consumption is a hereditary disease, or arises from a peculiar constitution transmitted from parents to children. This is what is called the *scrofulous* constitution, which can often be detected by a practised observer, but of which it is not easy to give any definition, except that the formation of tubercular (cheesy) matter in any part always denotes it. When much developed, and when it affects the glands of the neck, it is vulgarly termed "king's evil." Constitutions are variously tainted with it, however, from a very slight to a very high degree; and it may easily be conceived how generally the taint is diffused, when we have stated that one in every four or five dies in this country from one of its forms. There are many other diseases, the tendency to which is derived from parents, such as asthma, insanity, gout, &c.; and there can be little doubt that this class of diseases constitutes the great bar to the physical improvement of the human stock. Until correct views on this subject become more general, little hope of improvement can be entertained. At present, persons in every rank make eager inquiries as to the worldly condition, &c., of those who are likely to form their partners for life; but how seldom does it happen that the tendency to even serious hereditary disease forms a bar to their union, or that persons even take the least pains to satisfy themselves where such exists! The great part of mankind neglect far too much the fact that they are animals, and that they are therefore subject to those general laws which regulate the transmission of peculiarities or diseases to their children. Hence, from this serious error, they fail to take the precautions which are necessary to secure an approach towards physical perfection in their own progeny, the neglect of which they would be ashamed of, even in regard to their dogs and their horses.

ting through with scissors the detached ribs near the breast-bone, and removing them. The breast-bone will thus be left in its place, supported by a rib or two at the top and bottom, and the division of the chest into two halves by the pleura—the heart lying in its bag or pericardium—as well as the appearance and position of the lungs, will be seen. Great care must be taken in opening into the chest, and in cutting the ribs posteriorly, not to injure the lungs. To show the action of the lungs, the windpipe must now be cut down upon in the neck, cut through, and detached, and a small tube tied into it. When this is gently blown into, the lungs will be seen to be inflated. A much more elegant mode of showing their action, however, is, carefully to take out both windpipe and lungs, and to attach them as represented in the following figure,



Rabbit's lungs in a bottle.

where *a* is a bottle, six or seven inches high, and about three wide, such as is used by druggists, with the bottom cut off; *b* is the rabbit's lungs (with the windpipe left moderately long) tied to a notched tin tube (*c*), that passes through a cork accurately fitting the neck of the bottle; *d* is a wooden piston, three-fourths of an inch thick, covered with soft leather, which is stuffed with hair, and oiled to make it fit accurately. When the handle of the piston is drawn quickly down, the air rushes by the tube and windpipe into the lungs, and inflates them, and this can be repeated by pushing the piston gently up, and then again drawing it quickly down. The bottle must be of the same width throughout, and the lungs must not be cut or injured in any part. The lungs should be in the bottle, and the windpipe tied on the tube, before the cork is fitted into the bottle. This is a remarkably striking experiment, and should be seen by every one who wishes to form a just conception of respiration. A pig's bladder will answer very well to show the nature of respiration. A beautiful experiment may be performed by procuring of a butcher a sound pair of calf's lungs, or lights, in

roduce a tube, and blow them up or inflate them. They suddenly expand, change their color, and present a very imposing effect. Every vessel but the trachea must be tied.

In my popular lectures on Physiology and the reformed practice, I repeatedly tried this interesting experiment. The boy who inflated the lung used no tube, but put the end of the windpipe into his mouth. His stomach was not very delicate. I have a model in wax by the best artist of the lungs, in connexion with the heart, which is extremely beautiful.

The power of oxygen in supporting combustion, and of carbonic acid in extinguishing it, should also be shown by introducing a lighted candle, fixed to a wire, into jars of these gases.

That the expired air contains carbonic acid, may easily be shown by breathing through a tube immersed in newly prepared lime water. The carbonic acid throws down the lime in the form of carbonate of lime.

By placing the ear to the upper part of the chest of a young person, the murmur produced by the air rushing through the air-vesicles may be heard; or the stethoscope may be used for hearing this, as well as the sounds of the heart.

Preparations of the bronchial tubes are generally made by anatomists with wax. These, however, have the disadvantage of being easily broken. There may be used, instead of wax, some of the metals. Equal parts of tin and lead answer well for the larger bronchi. Take a sheep's lungs, clear away fat, &c., but taking care not to injure them, and cut off the windpipe three or four inches above the lungs; dry the interior of the windpipe by introducing pieces of lint on the end of a stick, and afterwards allowing it to remain exposed to the air for a few hours. Then transfix the windpipe at the upper part with two darning-needles crossed, to hang the lungs by; fasten the needles to the ring of a retort-stand; fasten a wide-mouthed tin funnel, supported by another ring of the retort, in the windpipe, and pour in the melted metal; boil the lungs for two hours, cut out the preparation, and varnish with wax dissolved in boiling spirits of wine. A much more delicate preparation can be made in the following manner:—Instead of tin and lead, take the composition called the *fusible metal*,* and pour it into the lungs, and then place these in a large pot of water, to be kept boiling for an hour. The air is thus, in a measure, expelled; and

* The *Fusible Metal* may be composed of two parts bismuth, one lead, one tin, and one quicksilver, to be all melted together and well mixed.

as the metal melts at the boiling point of water, it finds its way into the most minute ramifications. When heated, the air in the air-tubes causes the lungs to become buoyant, which prevents the metal getting properly into the lower bronchi. To obviate this, the lungs may be enveloped in a cloth, which should be loaded with heavy weights, to keep them in the upright position. As the metal is extremely brittle when hot, the lungs should not be taken out of the pot till they are cold; then hang them in some place where flies can deposit their eggs, moistening the outside daily, and allow them to remain until the maggots eat away all the flesh; after this, hang them in water until the preparation can be easily cleaned. In making both preparations, about one and a half pounds of metal are required, and the tin filler should be heated to make the metal run the easier. If any of the large branches are broken, any tin-smith will easily solder them. When well managed, preparations made in this way have a truly wonderful appearance; the bronchial tubes, though beautifully distinct, and as fine as hairs, presenting almost a solid mass. The existence of air-vesicles has been doubted by some authors, and these preparations seem to support this opinion.

Other illustrative figures for this section will be found in Bell's Anatomy, vol. i., page 699; Dr. Smith's Philosophy of Health, vol. i., p. 243; "Animal Physiology," in the Library of Useful Knowledge, pp. 88, 89, 92, &c., &c.

MEDICAL TREATMENT AND REGIMEN.

Having given a description of the structure, physiology, and diseases of the lungs, I will add a few remarks on the medical treatment and *regimen* of pulmonary disease, being the most common complaints of these organs. It is a melancholy fact, that diseases of the lungs cause greater mortality than all others together, particularly in all northern climates. In this country and in England, about one-fourth or fifth adult persons are taken off by consumption, the causes of which are various, principally sudden changes of the weather, which is exceedingly great, even not unfrequently during a single day. This checks the secretion of the skin, and retains deleterious agents, which become a source of irritation; and in addition to which that immense amount of blood which is constantly distributed to every part of the body, particularly the surface or skin, is forced inwardly by the refrigeratory influence of cold, and closes the capillary vessels, and drives the

blood back from their original channels to the internal organs of the system. This consequently engorges or congests them, and brings on inflammation, and perhaps ulceration, which may prove fatal; and especially so if there be any predisposition to scrofula or tubercular state of the lungs. Nearly every complaint of the kind can be traced to what is commonly called "colds."*

It is also more to be regretted that notwithstanding all our researches, we have not been able to discover a remedy for confirmed tubercular consumption. I know that it is sometimes removed in the incipient state, and even when apparently there has been no prospect of recovery; but this forms only exceptions to a general rule. Every philanthropic physician then should exert all his abilities to investigate the pathology or nature of this disease, and find a cure. "Who knows," says Dr. Rush, "but there grows a plant at the foot of the Alleghany Mountains that will prove a remedy for consumption?" Notwithstanding the discouraging aspect, much may be done both to prevent and to cure. To accomplish the first, avoid every exciting cause, and especially a check of perspiration, which is the great and first cause of it. As pneumonia, or inflammation of the lungs, usually ushers in the complaint, it must be either reduced or moderated by attention to the secretions and excretions of the system, counter-irritants, &c. Bleeding must by no means be resorted to; it only has a tendency to exasperate the symptoms by abstracting that vital fluid on which the restorative success depends. If the disease has become seated, strong *tonics*, *expectorants*, and sedatives are indicated. Horseback exercise is a powerful means of recovery. Bathe the surface daily with cold weak ley-water, followed by friction. This is a valuable auxiliary, especially to remove that predisposition to those frequent coughs which precede the disease. *The artificial asses' milk* mentioned in my Medical Dictionary, under the head, I think, of *Sea Holly*, has been highly extolled by a physician who used it very extensively, and it is said was invariably successful in its treatment. The diet should be nutritious; milk, warm from the cow, is excellent. A sea voyage and a change of climate sometimes is attended

* The barbarous Chinese custom of contracting the feet of women, and the great extent to which their irrational purpose is accomplished, are well known. While the Europeans were expressing their surprise at such an absurdity, and pitying the sufferers, they were constantly permitting under their own eyes the equally, if not more pernicious practice of tight stays; by which I have seen the figure of the thorax completely and permanently altered at its lower part—a great cause of consumption, by impeding the motion of the lungs

with a salutary effect. The best climate is the Brazils, at Para, situate on the river Amazon. An excellent preventative for chronic bronchial affections is the application, two or three times a day, of cold water to the neck and chest, followed by friction with a coarse towel. The irritating plaster is also very valuable. For more particular medical treatment, see my Reformed Practice. Also for other diseases of the lungs.

The Stethoscope has of late become very common among physicians in forming a diagnosis or opinion of pulmonary diseases. I have very little confidence in it myself. Lugol, of Paris, has the following remarks on the use of it:—

“The numerous checks and repeated deception to which physicians are daily exposed in the DIAGNOSIS and TREATMENT of tuberculous diseases, do they not prove that it is necessary to leave the beaten track of inquiry and pursue some other which is less fallible? You all know that auscultation and percussion are useless in the diagnosis of pulmonary tubercles. Both alike insufficient to announce the commencement of the mischief, they are superfluous at the very time that they become capable of indicating the presence of the tubercles; for then these are discoverable by other means, and, alas! are too far advanced in their development to warrant our hopes of arresting their progress—at least in the generality of cases. I will even go a step further, and say that the unlimited confidence placed by the greater number of practitioners of the present day in auscultation and percussion, has had the effect of too often inspiring a fatal security in many tuberculous diseases, which are thereby allowed to advance in their progress, until this is revealed by physical phenomena at a period when remedial measures have but little chance of effecting any good.

“But what are the means, you will say to me, that are to be substituted in the room of auscultation and percussion? I answer, gentlemen, induction. Examine by these boasted methods this patient, and tell me what results you obtain. Negative results, you will reply. And yet I maintain that he is tuberculous; for his father, his mother, and his brothers have all died of tuberculous disease; and he himself is affected with it in his chest at the present moment. Believe me, this plan is much less deceptive than the other one. I tell you, the inductive method cannot mislead you, for nature is invariable in its causes as in its effects; and the external signs of tuberculous scrofula must give you assurance that

similar morbid productions exist in internal organs, especially in the lungs.

"It is by viewing the question from this elevated point of view, by studying it in all its *ensemble*, that you will be best enabled to comprehend it in its details ; and these cannot be understood by the special methods of examination which have been so much recommended of late years.

"The tubercularization of internal organs exhibits in its development the same phenomena as tubercles which are outwardly situated—there is no pain, and nothing of mechanical derangement.

"The existence of tubercles in the lungs is so frequent, that I must admit that they are present in all scrofulous persons. You know that all, or almost all, patients, who have pulmonary tubercles, are, or have been at some time, affected with tubercles in the neck ; the majority have had during infancy this external sign of scrofula ; while others have had it at a later period of life. I believe that pulmonary tubercles frequently exist in early youth ; but it is chiefly about the age of puberty that they are apt to be developed."

A person in this city informs me that he has derived great benefit for a seated cough by breathing through an ivory tube with a small aperture at the end to allow the air to pass through slowly, that the lungs may become expanded and exercised.

Says Lawrence on Man : "The accumulation of numbers in large cities, the noxious effects of impure air, sedentary habits, and unwholesome employments ;—the excesses in diet, the luxurious food, the heating drinks, the monstrous mixtures, and the pernicious seasonings, which stimulate and oppress the organs,—the unnatural activity of the great cerebral circulation, excited by the double impulse of our luxurious habits and undue mental exertions, of the violent passions which agitate and exhaust us, the anxiety, chagrin, and vexation, from which few entirely escape, and then re-acting on and disturbing the whole frame ;—the delicacy and sensibility to external influences, caused by our heated rooms, warm clothing, inactivity, and other indulgences, are so many fatal proofs that our most grievous ills are our own work, and might be obviated by a more simple and uniform way of life. Our associates of the animal kingdom do not escape the influence of such causes. The mountain shepherd and his dog are equally hardy, and form an instructive contrast with a nervous and hysterical fine lady, and her lap-dog ;—the extreme point of degeneracy and imbecility of which the latter is susceptible."

CHAPTER VIII.

CIRCULATION.

I WILL commence this subject with a description of the heart and blood-vessels, and then describe the circulation.

In all those animals which most resemble man (anatomically), such as the monkey, the dog, horse, ox, &c., the *heart* is placed between the two lungs, in the cavity of the chest, which anatomists call the *thorax*.

The general form of the heart is that of an inverted cone, the apex down, and a little to the left. The size of the heart is very nearly that of the fist of the individual to whom it belongs.

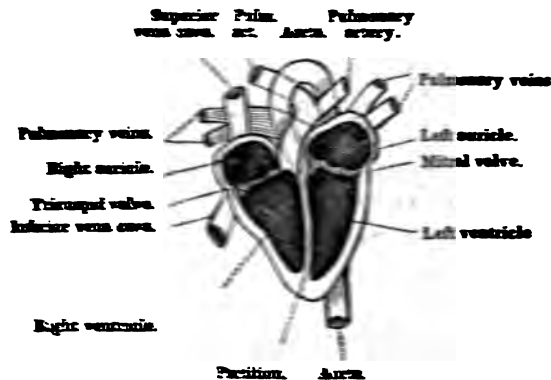
This organ is enveloped in a double membranous sac, called *pericardium*, and is suspended in the pericardium by the vessels which arise from its superior and enlarged extremity; but it does not adhere at any other point of its surface to the neighboring parts.

The substance of the heart is almost entirely fleshy; it is a hollow muscle, the cavity of which communicates with the arteries and veins.

In man and all the mammalia, as well as birds, it has four distinct cavities. A thick, vertical partition divides it into two halves, each one forming two cavities, one above the other; a *ventricle*, and an *auricle*.

The two ventricles occupy the inferior part of the heart, and do not communicate with each other, but each one opens into the auricle above it.

The heart, then, may be described as a hollow muscle, which, in birds and mammalia, as in man, is divided into four distinct chambers, as shown in the following figure. This division is effected



by a strong *vertical* partition, that divides the entire heart into two halves, which are almost exactly similar to each other, excepting in the greater thickness of the walls on the left side; and each of these halves (which do not communicate with one another) is again subdivided by a transverse partition, into two cavities, of which the upper one is termed the *auricle*, and the lower the *ventricle*. Thus we have the right and left auricles, and the right and left ventricles. Each communicates with its corresponding ventricle, by an aperture in the transverse partition, which is guarded by a valve. The walls of the ventricles are much thicker than those of the auricles; and for this evident reason,—that the ventricles have to propel the blood, by their contraction, through a system of remote vessels; whilst the auricles have only to transmit the fluid that has been poured into them by the veins, into the ventricles, which dilate themselves to receive it. The comparative thickness of the walls of the left and right ventricles is explainable on the same principle; for the left ventricle has to send the blood, by its contractile power, through the remotest parts of the body; whilst the right has only to transmit it through the lungs, which, being much nearer, require a far less amount of force for the circulation of the blood through them.

We are thus brought, then, to consider a second important department of our science, the circulation of the blood; but, first, it is necessary to inquire into the nature of the blood itself.

With the appearance of *blood*, as it occurs in the higher classes of animals, every one is familiar. When drawn from one of the vessels which immediately receive it from the heart, and which are *red arteries*, it is of a bright scarlet color: but when taken, as it *is* in the common operation of bleeding, from a vein, it is

much darker, being of the shade called by painters *Modena red*. When first drawn from the vessel, it is a somewhat glutinous and apparently homogeneous fluid, but, after standing for a short time, it separates into two parts, one a watery part, called the *serum*, the other a more solid part, called the clot, or *crassamentum*. The serum is chiefly composed of water, with a considerable quantity of the same substance as the white of the egg (*albumen*) dissolved in it; so that, if it is exposed to a boiling heat, this coagulates and makes the whole solid. The clot, again, likewise consists of two principal substances, one of which gives it the red color, and, by repeated washings, can easily be separated from the other, which is a white, tough, fibrous matter. It is known by the name of *fibrin*, and is said to be nearly identical in composition with the part that gives contractility to the muscles.*

Although the blood in all animals appears to be of essentially the same nature, separating when out of their bodies into a solid and a serous part, yet, in a large proportion of the lower classes, it has not the same florid appearance which it assumes in most of the *Vertebrata*. Thus, in insects, this fluid is nearly transparent, while in the caterpillar it has a greenish hue. In fishes, again, it is transparent in the bulk of the body, but it has a red color in the gills, heart, and liver; and even in the human body, some textures, as the transparent parts of the eye, circulate only a colorless fluid. In certain diseased states of the system, indeed, nearly the whole blood becomes colorless.

When the blood is examined with a microscope, its florid color is perceived to arise from the numberless extremely minute red globules suspended in the watery serum. These have, in every species where they exist, a determinate size and form, being in man of a circular flattened shape, and from the three-thousandth to the five-thousandth part of an inch in diameter. In birds, reptiles, and fishes, they get progressively larger, assuming at the same time an elliptical form. Their number corresponds very constantly to the temperature of the animal, and hence the two divisions of warm and cold-blooded. In birds the red globules constitute, in general,

* The following, made by M. Le Canu, is the most recent analysis of the composition of the human blood:—Water, 786.500; albumen, 69.415; fibrin, 3.555; coloring matter, 119.626; crystallizable fatty matter, 4.300; oily matter, 2.270; extractive matter, soluble in alcohol and water, 1.920; albumen combined with soda, 2.010; chloruret of sodium and potassium, alkaline phosphate, sulphate and subcarbonate, 7.304; subcarbonate of lime and magnesia, phosphates of lime, magnesia and iron, peroxide of iron, 1.414; loss, 2.586. Total, 1000.

about fourteen or fifteen per cent. by weight of the whole mass, in man twelve or thirteen per cent., and both of these are warm-blooded animals. The red globules in fishes (which are cold-blooded, or only slightly warmer than the water in which they live) amount to about five or six per cent. It is also stated that these globules are in general more numerous in the blood of men than in that of females, and in persons of a sanguine than in those of a lymphatic temperament.

One of the most singular properties of blood, is its power of coagulating. It has been supposed that the globules of blood are really vesicles or bags, the outer portion of which is composed of red coloring matter, while the centre consists of fibrin; and that, during coagulation, the vesicle is burst, and the particles of fibrin adhere to each other. But it has been more recently shown, by the experiments of Babington and Müller, that the fibrin is not contained in the red globules, but in the fluid part of the blood in which they float. When inflammation exists, the separation of the two parts is most complete, the yellow or upper buffy layer being the fibrin. Much beautiful design, as Dr. Prout remarks, is probably concealed under this arrangement. One object of it is evident. If the blood did not coagulate, the existence of animals would be most precarious, as, on the slightest injury, they would be liable to bleed to death.

There must, therefore, evidently be a cause for the fluidity of the blood within the body, and many experiments render it highly probable that this depends, to a certain extent at least, upon the vitality of the veins and arteries circulating it. Even the vitality of the blood itself is made more than probable by the experiments of Mr. John Hunter. Like the egg, it can, within certain limits, resist the influence of various agents, such as heat and cold, while it retains life, but yields to them when it dies. An electric shock passed through it, instantly extinguishes its vitality, and this is the reason why the blood in persons struck dead by lightning is always fluid.

While physiologists had yet but inaccurate ideas of the uses and structure of different organs, great benefits it was thought might follow from transfusing a healthy animal's blood into a diseased person's body, and some dangerous and even fatal experiments of this kind were performed in France, until the practice was interdicted by law. Of late years the practice has been revived, in cases where great loss of blood has happened, and its previous failure has

been shown to have arisen from transfusing the blood of one species into the body of another, in which the globules are of a different size or shape. The blood of a sheep, for example, transfused into a cat or rabbit, causes death in a short time; and instantaneous death follows the transfusion of blood with circular globules into an animal which has these elliptical.

If other substances are mingled with the blood, equally serious effects follow. Farriers produce instantaneous death in horses by blowing air into their veins; and a person in Paris, a few years ago, who was having an operation performed in which a large vein in the neck had to be cut, from the entrance of air fell over and expired. No less than about thirty other cases have been published, in which it is probable death occurred from the same cause.

Having made these observations regarding the blood, we must now explain the means employed for its circulation; and in doing so, we shall first describe this as it takes place in man and in the other Mammalia; for though their circulating system is really the most complex, a knowledge of it forms a key to all the modifications which it sustains in the other classes.

The course of the circulation of the blood was unknown until the reign of James I., when it was discovered by Dr. Harvey. The ancients knew of the existence of the veins and arteries, but thought that the blood was moved backwards and forwards in the veins, and that the arteries were filled with air. The name of the latter, indeed, is derived from *arteria*, or air-tube. Harvey publicly taught his new doctrines as early as 1616; but, with a caution worthy of one whose fame was to be coeval with our race, spent no less than twenty-six years in amassing materials for his immortal work on the circulation. The reception it met with, when published, is instructive. Derided by his own profession as a quack, he was looked upon by the vulgar as crack-brained, as is always the case with the ignorant, prejudiced, and jealous; and in a letter written to a friend at this period, he complains that his practice had suffered seriously since the publication of his book. To the honor of mankind, however, it must be said that he lived long enough to see his system taught in every university in the world.

The circulating system in the Mammalia may be said to consist of four principal parts—first, the heart, which is the centre of the whole; second, the arteries, which receive the blood from the heart; third, the veins, which return the blood to the heart; and,

fourth, the capillary (hair-like) vessels, which unite the termination of the arteries with the commencement of the veins.

Every one knows the appearance of the heart—an ox's or a sheep's, for example. When cut up, it is found to consist of four cavities, two on the right side that communicate with each other, but not directly with those opposite. The diagram or figure affords an exact representation of the human heart, with the circulation of the blood to and from the lungs on both sides.

To make the course pursued by the blood more plain, we take asunder the two sides or chambers of the heart, and represent them as separate from, and opposite to, each other, as seen in the figure adjoining.

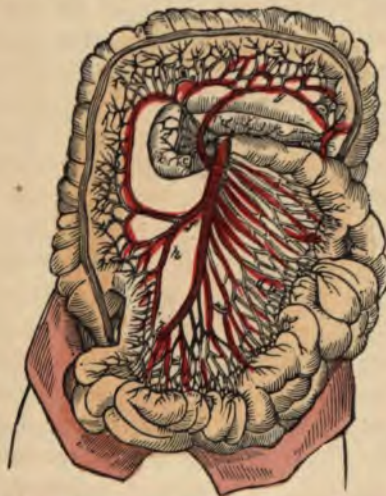
In this *ideal* plan of the circulation in the Mammalia, the arteries and veins are *supposed* to be thrown into continuous chains, with the capillaries as their connecting links. In describing this plan, we shall commence with the veins. It will be seen that they gradually unite, until those coming from above and those from below form two large vessels (*venæ cavæ*), that empty themselves into the upper cavity of the heart on the right side, called the *right auricle*. From the contraction or drawing together of this auricle, the blood easily passes downwards into the next cavity, called the *right ventricle*; and this, which is still more powerful, also in its turn contracting upon the blood, sends it through the vessel (*p a*), called the *pulmonary artery*. It is plain, however, that, if nothing hindered it, the blood could as easily go back to the right auricle, as forwards into the pulmonary artery; but this is effectually prevented by a valve that is placed between the right auricle and the right ventricle and which allows the blood to enter, but prevents it going back. Another valve, which acts in a similar manner, is placed at the mouth of the pulmonary artery, so that the blood, by the successive contractions of the ventricle, is forced to go forward into the lungs. Here, as will afterwards be explained, it becomes purified, as is shown by its red color, and is sent by the *pulmonary veins* (*p v*) to the *left auricle* of the heart, to pass, as on the other side, into the *left ventricle*. This last is the most powerful of all the parts described, as it is required to propel the blood into the artery called the *aorta* (*o a*), and from it into the whole of the body. Valves are placed on the left side, between the auricle and ventricle, and at the mouth of the aorta, which have a similar action and appearance to those on the right side. Those between the auricles and ventricles are called *cuspid*, that is, pointed valves; on the right side

FIG. 33. CIRCULATION OF THE BLOOD.



Two halves of the Heart a little separated. *g* Left side. *a* Aorta. *c a p* Capillary vessels which terminate the artery. *v* Venous system. *d* Right side of the Heart. *a p* Pulmonary artery. *v p* Pulmonary vein. The arrows show the course of the blood.

FIG. 34. SUPERIOR MESENTERIC ARTERY.



It arises from part of the Aorta and supplies the Mesentery with blood. It also sends off branches to the Intestines. The course of the Colon is shown in the figure.



from having three points, *tricuspid*; on the left side, from having two points, *bicuspid*. Again, those at the mouths of the pulmonary artery and aorta, are, from their shape, called *semilunar valves*.

The blue color at once gives an idea of the parts of the body in which impure or venous blood is circulated (the veins, right side of the heart and pulmonary artery). The red color also indicates in what part the blood becomes purified (the lungs), and where it is circulated as arterial or pure blood (the pulmonary veins, left side of the heart, and arteries). It is in the capillaries between the arteries and veins (which are too minute to be fully represented in the figure, but which pervade every point in our bodies) that the blood parts with its vivifying qualities. (See plate.) The communication of these qualities to the different structures, may be said, indeed, to constitute the great object of the circulation. The arrows in the figure show the course pursued by the blood. The figure shows the situation of the heart in the chest, with the aorta and its branches going off from it. The two ventricles are seen united. The two auricles are also seen. The carotid arteries going to the head. The superior vena cava (which empties itself into the right auricle), in which the jugular veins from the brain, and the subclavian veins from the arms, are seen to terminate. The water-works of our city represent the circulation of the blood—the reservoir the heart, the pipes the arteries.

The course of the circulation, as shown in the figure, will now be easily understood. The two venæ cavæ empty themselves into the right auricle. From this the blood passes into the right ventricle, which sends it into the pulmonary artery, and this immediately divides in the lungs into innumerable branches, only a few of which are represented in the figure. In the lungs, as already mentioned, the blood is purified, and the pulmonary veins are therefore represented as bringing back to the heart red or arterial blood. The pulmonary veins from both sides pour their supplies of blood into the left auricle, from which again it passes into the left ventricle, and is by the latter sent to all parts of the body through the aorta and its branches, to be again conveyed by the veins to the right side of the heart. By attending to the directions indicated by the arrows, the course of the circulation in this and the other figures will be made very plain.

To recapitulate what has just been said, on the route pursued by the blood, in the apparatus of the circulation in mammiferous animals and birds, we see :

i. That the venous blood arrives from all parts of the body by the venous system or veins.

ii. That from these veins it enters the right auricle of the heart;

iii. That from the right auricle it passes into the right ventricle;

iv. That from the right ventricle the venous blood passes through the pulmonary artery to the lungs.

v. That in the capillary vessels, which form the termination of the pulmonary artery, and commencement of the pulmonary vein, this blood is changed into arterial blood.

vi. That this arterial blood returns from the lungs, through the pulmonary vein, and enters the left auricle of the heart:

vii. That from the left auricle it ascends into the ventricle of the same side.

viii. That from the left ventricle it is forced into the aorta, by which it is distributed to all parts of the body.

And finally—and finally, that in the capillary terminations of the system of vessels formed by the aorta, the arterial blood acts upon the organs, is changed there into venous blood, and enters the veins to be carried again to the heart.

In accomplishing the circulatory office, the blood then passes twice through the heart, in the state of venous blood on the right side, and in the state of arterial blood on the left side of this organ; yet the circulation is complete, because the pulmonary and aortic cavities of the heart do not open one into the other, and the venous blood passes through the entire respiratory apparatus to be transmuted into arterial blood.

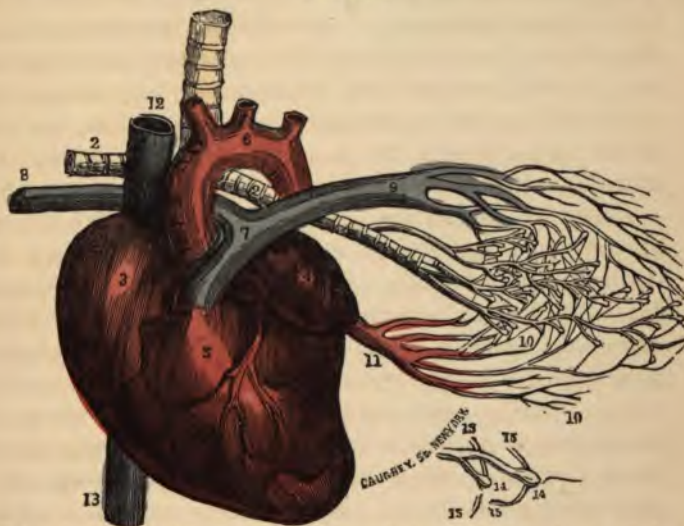
From the description given, it must be plain that the office filled by the heart, with its accurately-working valves, is essentially that of a forcing-pump. And with what inimitable precision and regularity does it perform this all-important duty! Unweariedly during the whole term of a long life it sends out daily its one hundred thousand waves of healthful fluid to refresh and renovate every corner of the system: and small as each wave may be individually, the aggregate amount is enormous. Thirteen thousand pounds of blood pass out of the left ventricle of the heart of an ordinary man every twenty-four hours. But the aorta of man is not an inch in diameter, whereas the aorta of a whale is three feet two inches in circumference. Well, therefore, might Dr. Paley say, that the circulation is a serious affair in such an animal. "The aorta of the whale," he, "is larger in the bore than the main pipe of the waterworks at London Bridge; and the water roaring in its pas-

FIG. 25.



1 The right ventricle. 2 The left ventricle. 3 The right auricle. 4 The left auricle. 5 The pulmonary artery. 6 The right pulmonary artery. 7 The left pulmonary artery. 8 The remains of the ductus arteriosus. 9 The arch of the aorta. 10 The superior vena cava. 11 The right arteria innominata. 12 The right subclavian vein, and behind it its corresponding artery. 13 The right carotid artery and vein. 14 The left vena innominata. 15 The left carotid artery and vein. 16 The left subclavian vein and artery. 17 The trachea. 18 The right bronchus. 19 The left bronchus. 20, 20 The pulmonary veins; 18, 20 from the root of the right lung; and 7, 19, 20 the root of the left. 21 The superior lobe of the right lung. 22 Its middle lobe. 23 Its inferior lobe. 24 The superior lobe of the left lung. 25 Its inferior lobe.

FIG. 26.



1 The trachea. 2 The right and left bronchus. 3 Right auricle of the heart. 4 Left auricle. 5 Right ventricle. 6 The aorta arising from the left ventricle, the left ventricle being in this diagram concealed by the right. 7 Pulmonary artery arising from the right ventricle and dividing into, 8 The right, and 9 The left branch. 10 Branches of one of the pulmonary veins proceeding from the terminations of the pulmonary artery on the air vesicles, where together they form the net-work of vessels termed the Rete Mirabile. 11 Trunk of the vein on its way to the left auricle of the heart. 12 Superior vena cava. 13 Inferior vena cava. 14 Air vesicles magnified. 15 Blood-vessels distributed upon them.



sage through that pipe, is inferior in impetus and velocity to the blood gushing through the whale's heart."

But if we are astonished in reflecting what must take place in the aorta of the whale, our admiration will be not less excited on examining the circulation even in the web of a frog's foot. When this is brought under a moderately powerful microscope, we can perceive with ease through the transparent coats of the tiny vessels, the red globules of the blood—in some singly, with long intervals between—in others, two abreast—and, in others still, numbers crowded together—pursuing their beautiful course, like the trains of spectral figures that pass before us in our dreams—now moving onwards with the most steady regularity, and again hurried forward by the struggles of the little animal. This sight, an excellent writer well observes, "is one which no man who has once seen can ever forget; and he who has not seen it, has not seen one of the most curious, and wonderful, and beautiful objects which animated nature presents."

Like most of the organs of organic life, the heart, in its usual state, gives us but slight indications of sensibility. Harvey met with an extraordinary opportunity of showing this. A young nobleman, from disease, had the heart exposed, so that it could even be handled while beating; and Harvey, to his astonishment, found that, unless his fingers came in contact with the outer skin, the young man was altogether unconscious of the heart being touched. Though nearly destitute of the sensations of touch, however, the heart is instantly affected by every powerful bodily excitement, or strong mental emotion. Upon the first of these depends the use physicians make of the pulse (which is just the heart's beat transmitted through the arteries) in judging of the different bodily ailments; while the power of emotions over the heart has furnished the poetry of all languages with some of its strongest images. The capillaries also share in the influence of emotions, of which we have a familiar example in blushing.

The greater or less vigor with which the blood is circulated through the system, gives rise to important effects. We see this particularly in two forms of constitution. In the one, the circulation is very vigorous; all the functions are performed with energy; and the diseases in general are of an acute character. When the complexion is fair, this constitutes what has been called the sanguine temperament—when dark, the choleric. In the other variety, the circulation, and all the functions connected with it, are languidly

performed ; the surface is easily chilled, and the diseases have frequently a low insidious character. When the complexion is fair, this has been called the phlegmatic temperament, and the melancholic when the complexion is dark. With a feeble circulation, the general health never can be good ; and hence we find the action of the heart weak in most delicate persons.

The arteries, like the intestines, are composed of three coats, and the middle one is generally considered to be muscular, in order to assist the contractions of the heart ; but its muscularity is by no means so marked as is the muscularity of the intestinal canal. These coats possess also different degrees of distensibility, the inner one having the least. This gives rise to the remarkable circumstance, that when, as in those horrid accidents that are sometimes caused by machinery, a limb is torn off, frequently not a spoonful of blood will be lost. The reason is, that the inner coat, which is ruptured first, curls up, and, assisted by the outer coat, forms a plug in the blood-vessels. These coats are sometimes distended more gradually by the continued impulse of the heart, constituting the disease called aneurism. The sac thus formed, if on the largest vessels, occasionally attains the size of a child's head, and produces instantaneous death when it ultimately bursts.

The part of the circulating system most liable to disease is the valves, and especially those of the left side of the heart. Ossification, or the disposition of bone in their substance, is what most commonly affects them. As might be anticipated, the blood regurgitates and stagnates, and great distress in breathing, dropsy, &c., are the consequences. The only other valves in the circulating system are in the veins, and they seldom become diseased.

The cavities of the left side of the heart contain arterial blood, and those of the right side, venous blood.

The vessels which convey arterial blood into all the organs take their origin from the left ventricle of the heart, through the medium of a single trunk, called the *aorta*.

This great artery first mounts upwards towards the base of the neck, then bends downwards, forming a sort of crook, passes behind the heart and descends vertically, in front of the spine, to the lower part of the belly. In its course, the aorta gives off a great number of branches, the principal of which are :

1st. The two *carotid arteries* mount along the sides of the neck, and supply the head with blood.

2d. The two arteries of the upper extremities, successively

obtain the names of *subclavian*, *axillary*, and *brachial* arteries, as they pass under the clavicle, or cross the armpit, or descend along the arm to the elbow, where they divide into two branches, called the *radial* and *ulnar*, or *cubital* arteries.

3d. The *intercostal arteries* are several in number, and run between the ribs on each side of the body.

4th. The *celiac* artery, which is distributed to the stomach, the liver, and the spleen.

5th. The *mesenteric* arteries, which ramify upon the intestines.

6th. The *renal* arteries, which penetrate into the kidneys.

And 7th. The *iliac* arteries, which in a manner terminate the *aorta*, and which convey blood to the lower extremities, descend along the thighs, and are there called femoral arteries; then they divide into many branches which terminate in the feet.

The *veins*, which receive the blood thus transmitted to all parts of the body, follow very nearly the same course as the arteries; but they are larger, more numerous, and generally situated more superficially. A great number of these vessels pass beneath the skin, others accompany the arteries, and, at last, they all unite to form two great trunks which empty into the right auricle of the heart, and which have received the names of *vena cava superior* and *vena cava inferior*.

The veins which come from the intestines present an important peculiarity. After uniting in a large trunk, they penetrate the liver, and there ramify like the arteries; there they again unite into a trunk and terminate in the inferior vena cava close to the heart. This arrangement of the vessels is called the *system of the vena porta*.

When the chambers of the heart which open into each other, and which as freely communicate with the great vessels that enter and proceed from them, are forcibly closed, and the blood they contain is projected from them, how is one uniform forward direction given to the current? Why, when the right ventricle contracts, is the blood not sent back into the right auricle, as well as forward into the pulmonary artery? There is but one mode of preventing such an event, which is to place a floodgate between the two chambers; and there a floodgate is placed, and that floodgate is the valve. As long as the blood proceeds onwards in the direct course of the circulation, it presses this membrane close to the side of the heart, and thereby prevents it from occasioning any impediment to the current. When, on the contrary, the blood is forced back-

ward, and attempts to re-enter the auricle, being of course driven in all directions, some of it passes between the wall of the ventricle and the valve. The moment it is in this situation it raises up the valve, carries it over the mouth of the passage, and shuts up the channel. There cannot be a more perfect flood-gate.

This is beautiful mechanism ; but there is another arrangement which surpasses mere mechanism, however beautiful. It has been shown that one edge of the membrane that forms the valves is firmly adherent to the wall of the ventricle, while the other edge, when not in action, appears to lie loosely in the ventricle. Were this edge really loose the reflux current would carry it back completely into the auricle, and so counteract its action as a valve ; but it is attached to the tendinous threads proceeding from the fleshy columns that stand along the wall of the ventricle. By these tendinous threads, as by so many strings, the membrane is firmly held in its proper position ; and the reflux current cannot carry it into the auricle. Thus far the arrangement is mechanical. But each of these fleshy columns is a muscle, exerting a proper muscular action. Among the stimulants which excite the contractility of the muscular fibre, one of the most powerful is distension. The reflux current distends the membrane ; the distension of the membrane stretches the tendinous threads attached to it ; the stretching of its tendinous threads stretches the fleshy column ; by this distension of the column it is excited to contraction ; by the contraction of the column its thread is shortened ; by the shortening of the thread the valve is tightened, and that in the exact degree in which the thread is shortened. So, the greater the impetus of the reflux blood, the greater the distension of the membrane ; and the greater the distension of the membrane, the greater the excitement of the fleshy column, the greater the energy with which it is stimulated to act, the greater, therefore, the security that the valve will be held just in the position that is required, with exactly the force that is needed. Here, then, is a flood-gate not only well constructed as far as regards the mechanical arrangement, but so endowed as to be able to act with additional force whenever additional force is requisite ; to put forth on every occasion, as the occasion arises, just the degree of strength required, and no more.

The contraction of the heart is the power that moves the blood ; and this contraction generates a force which is adequate to impel it through the circle.

It has been shown that the different chambers of the heart have

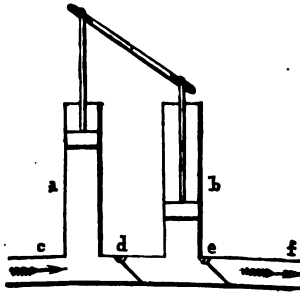
a tendency to perform their movements in a uniform manner, and in a successive order; that they contract and dilate in regular alternation, and at equal intervals; but, moreover, they continue these movements equally without rest and without fatigue. On go the motions, night and day, for eighty years together, at the rate of a hundred thousand strokes every twenty-four hours, alike without disorder, cessation, or weariness. The muscles of the arm tire after an hour's exertion, are exhausted after a day's labor, and can by no effort be made to work beyond a certain period. There is no appreciable difference between the muscular substance of the heart and that of the arm. It is true that the heart is placed under one condition which is peculiar. Muscles contract on the application of stimuli; and different muscles are obedient to different stimuli,—the voluntary muscles to the stimulus of volition, and the heart to that of the blood. The exertion of volition is not constant, but occasional; the muscle acts only when it is excited by the application of its stimulus: hence the voluntary muscle has considerable intervals of rest. The blood, on the contrary, is conveyed to the heart without ceasing, in a determinate manner, in a successive order; and this is the reason why through life its action is uniform: it uniformly receives a due supply of its appropriate stimulus. But why it is unwearied, why it never requires rest, we do not know. We know the necessities of the system which render it indispensable that it should be capable of untiring action, for we know that the first hour of its repose would be the last of life; but of the mode in which this wonderful endowment is communicated, or of the relations upon which it is dependent, we are wholly ignorant.

The force exerted by the heart is vital. It is distinguished from mechanical force in being produced by the very engine that exerts it. In the best-constructed machinery there is no real generation of power. There is merely concentration and direction of it. In the recoil of the spring, in the re-action of condensed steam, the energy of the expansive impulse is never greater than the force employed to compress or condense, and the moment this power is expended, all capacity of motion is at end. But the heart produces a force equal to the pressure of sixty pounds by the gentlest application of a bland fluid. Here no force is communicated to be again given out, as in every mechanical moving power; but it is new power, power really and properly generated; and this power is the result of vital action, and is never in any case the result of action that is not vital.

MECHANISM OF THE CIRCULATION.

The mechanical action, by which the blood is caused to circulate in the vessels, is easily comprehended. The cavities of the heart, as already explained, contract and dilate alternately, by the alternate shortening and relaxation of the muscular fibres that form their walls; and the force of their contraction is sufficient to propel the blood through the vessels which proceed from them. The two ventricles contract at the same moment; the auricles contract during the relaxation of the ventricles, and are themselves relaxed whilst the ventricles are contracting. The series of movements is, therefore, as follows:—The auricles being full of blood which they have received from the *venæ cavæ* and pulmonary veins, discharge it by their contraction into the ventricles, which have just before emptied themselves into the aorta and pulmonary artery, and which now dilate to receive it. When filled by the contraction of the auricles, these contract in their turn, so as to propel their blood into the great vessels proceeding from them; and whilst they are doing this, the auricles again dilate to receive the blood from the venous system, after which the whole process goes on as before. It is when the ventricles contract, that we feel the *beat* of the heart, which is caused by the striking of its lower extremity against the walls of the chest; and it is by the same action that the pulse in the arteries is produced.

The combined action of each auricle and its ventricle may be illustrated by an apparatus like that represented in the following figure. It consists of two pumps, *a* and *b*, of which the pistons move up and down alternately; and these are connected with a pipe, *c f*, in which there are two valves, *d* and *e*, opening in the direction of the arrow. The portion *c* of the pipe represents the venous trunk, by which the blood enters the heart; the pump *a* represents the auricle, and the raising of its piston enables the fluid to enter and fill it. When its piston is lowered, its fluid is forced through the valve *d* into the pump *b* (which represents the ventricle), whose piston is at the same time raised to receive it; and when this piston is lowered in its turn, the fluid (being prevented from returning into *a* by the closure of the valve *d*) is propelled through the valve *e* into the pipe *f*, which may represent an arterial tube; whilst at the same time a fresh supply of blood is received into the pump *a* by the raising of its piston.



Such is the description, and with the exception of the first proof, such the evidence of the circulation of the blood in the human body, pretty much as it was given by the discoverer of it, the illustrious Harvey. Before the time of Harvey, a vague and indistinct conception that the blood was not without motion in the body had been formed by several anatomists. It is analogous to the ordinary mode in which the human mind arrives at discovery, that many minds should have an imperfect perception of an unknown truth, before some one mind sees it in its completeness and fully discloses it. Having, about the year 1629, succeeded in completely tracing the circle in which the blood moves, and having at that time collected all the evidence of the fact, with a rare degree of philosophical forbearance, Harvey still spent no less than eight years in re-examining the subject, and in maturing the proof of every point, before he ventured to speak of it in public. The brief tract which at length he published was written with extreme simplicity, clearness, and perspicuity, and has been justly characterized as one of the most admirable examples of a series of arguments deduced from observation and experiment that ever appeared on any subject.

Contemporaries are seldom grateful to discoverers. More than one instance is on record in which a man has injured his fortune and lost his happiness through the elucidation and establishment of a truth which has given him immortality. It may be that there are physical truths yet to be brought to life, to say nothing of new applications of old truths, which, if they could be announced and demonstrated to-day, would be the ruin of the discoverer. It is certain that there are moral truths to be discovered, expounded, and enforced, which, if any man had now penetration enough to see them, and courage enough to express them, would cause him to be regarded by the present generation with horror and detestation. Perhaps, during those eight years of re-examination, the discoverer

of the circulation sometimes endeavored in imagination to trace the effect which the stupendous fact at the knowledge of which he had arrived would have on the progress of his favorite science ; and, it may be, the hope and the expectation occasionally arose that the inestimable benefit he was about to confer on his fellow men would secure to him some portion of their esteem and confidence. What must have been his disappointment when he found, after the publication of his tract, that the little practice he had had as a physician by degrees fell off. He was too speculative, too theoretical, not practical. Such was the view taken even by his friends. His enemies saw in his tract nothing but indications of a presumptuous mind that dared to call in question the revered authority of the ancients ; and some of them saw, moreover, indications of a malignant mind, that conceived and defended doctrines which, if not checked, would undermine the very foundations of morality and religion. When the evidence of the truth became irresistible, then these persons suddenly turned round and said, that it was all known before, and that the sole merit of this vaunted discoverer consisted in having circulated the circulation. The pun was not fatal to the future fame of this truly great man, nor even to the gradual though slow return of the public confidence even during his own time ; for he lived to attain the summit of reputation, and to see his great discovery taught in all the medical colleges, as before stated.

The parts of the circulating system most difficult to be understood, are the valves of the heart and their action. Both these can be beautifully shown in a cow's heart, the vessels of which have been cut high up, and as little injured as possible. The hard suet being cleared from the base of the heart, to show the bicuspid valve between the left auricle and ventricle, pass the finger into the large opening of the aorta (which is the vessel butchers often hang the heart by) nearest the heart, when will be felt the semilunar valves at the mouth of the left ventricle. These must be broken down by cautiously introducing a scalpel, or penknife, and cutting and then forcibly rupturing them with the finger. Having done this, close all the openings on the side of the aorta, by tying them, or transfixing them with a needle, and twisting thread round it, or putting a small cork in the largest, fastening with needles, and twisting thread round them, &c. Now pour water gently into the aorta, and notice where it escapes. This will be by the left auricle, which is to be cautiously removed (but not cut quite to its base), until the valves are exposed. If water is now poured quickly into the aorta,



THE ARTERIAL SYSTEM.

Showing the Aorta, or main pipe, from its orifice, together with its branches, and all the arteries with their various ramifications throughout the Human System, in their natural color, carrying, with fearful rapidity and power, the crimson fluid, from the great reservoir, the Heart, to the minutest part of the system, flowing in jets and causing the pulsations at the wrists.



THE VENOUS SYSTEM.

Showing the two *Vena Cavae*, or great veins, together with all the veins in the Human System, in their natural color, returning the blood to the great fountain, the Heart.

the bicuspid valve will be seen to be lifted up, and to prevent its escape; or, what is better, the air may be made to take the place of the water, by drawing in the breath and blowing forcibly, in quick succession, through the aorta. The action of the valve during life may thus be shown with tolerable accuracy.

When this has been examined the heart may be cut through transversely, two or three inches above the apex, to show the greater thickness of the left than the right ventricle; the left ventricle and aorta may then be cut up to show their internal surface—the fleshy columns and tendinous cords, which assist the heart in contracting, the appearance of the bicuspid and semilunar valves, the grooves leading to the branches from the aorta, &c.

The action of the semilunar valve may now be shown by cautiously cutting away the right ventricle, till the valves at the mouth of the pulmonary artery are exposed. Take a pig's bladder, and cut about two inches off each extremity. Sew the narrower end round the inner surface of the pulmonary artery; pour a jugful of water quickly into the bladder, and the action of the valves, in preventing its return, will be seen.

By mixing Paris plaster (which may be got from any plasterer) bulk for bulk with the water, casts of the pulmonary valves, of the left ventricle, &c., may be made, and cut out when dry. To take a cast of the right ventricle, the pulmonary valves must be broken down, as above. These make very instructive preparations, when the valves, &c., are distinguished by being colored.

Attention should also be directed to the great difference in muscularity between the auricles and ventricles, and to the sounds of the heart as they can be heard by applying the ear to the left side of the chest of a thin person. The first dull sound is supposed to be produced principally by the contraction of the ventricles, the succeeding sharp sound by the falling back of the blood on the semilunar valves. In disease, these sounds become louder and much altered—in some cases resembling the blowing of bellows, in others the rasping of a file, &c. The contraction of the heart is called its systolé, the time it rests its diastolé.

To show the fibrin of the blood, get some from the butcher (who extracts it by turning his fingers in the blood while coagulating), and wash it till it is pure white. The coagulability of the serum should be shown by heating it in a Florence flask.

As mentioned in the text, the microscope shows the circulation in a frog's foot.

Other figures to illustrate this section may be found in "Animal Physiology" in the Library of Useful Knowledge, pages 69, 70, 71, 73, 74; in Dr. Roget's Bridgewater Treatise; in Dr. Smith's Philosophy of Health; in Bell's Anatomy, &c.

The blood is subject to disease with other parts of the body, arising from various causes, and the most frequent is an unequal circulation of it. When the capillary system of the skin ceases to perform its functions, or does it imperfectly, the blood is diverted from its ordinary channels, and driven inwards to some of the organs, and by its preternatural accumulation, in connexion with retained morbid perspiratory matter, becomes a source of irritation and inflammation. This state of the system does not prove that there is too great a quantity of this fluid in the body, but that the balance of the circulation is lost; that there is not an equable distribution throughout the blood-vessels. The defective doctor now steps in, not as a servant of nature to assist her to return back the blood to its original channels by appropriate treatment, but abstracts a portion of it, and thus frustrates her intentions to accomplish this object.

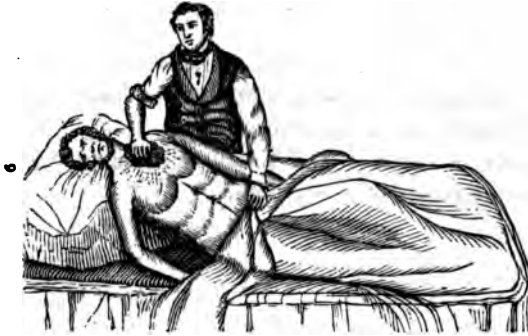
As the restorative process depends on the blood, just in proportion to the amount taken is the power to produce re-action diminished, and it appears to me to be as unphilosophical and unreasonable to bleed a man to cure him of a disease as it would be to lay an additional weight on anything which a person was exerting all his strength to lift. The inability to raise it would be just in proportion to the amount added, and thus the phlebotomist retards instead of assisting nature.

According to this view, then, the proper treatment consists not in lessening the quantity of blood in the system, but in equalizing it; and this must be effected by administering such medicines as cause a determination of the blood to the surface from whence it has retreated. Warm herb tea to be given, aided by warmth externally, as hot bricks, or bottles of hot water to the sides and feet. In some cases the vapor bath or a "rum sweat." The cardinal indication or intention to fulfil this is to *equalize* the circulation of the blood, not impair it, or abstract it. In those cases where there is a taint or impurity, *alterative* agents should be given.

IN FEBRILE DISEASES

Pursue the following course :—Commence by taking an emetic, and the next day take a cathartic. When the operation is over,

use means to produce free perspiration ; if the attack is severe, take a rum sweat. This may be done over a cane seat or open seated chair, with the patient divested of all clothing, but covered from the neck to the floor with two or three blankets or coverlids to keep in the vapor, and his feet placed at the same time in weak warm ley-water. Put a quantity of rum in a tin or earthen vessel, and place it underneath the chair, and set fire to it. Let the patient continue in this situation till free perspiration is produced ; then remove him to the bed, and give freely of herb tea as before directed. When the perspiration has subsided, take weak ley-water, rather cool, dip a sponge or towel into it, and, if the patient is unable to sit up, raise the clothes with one hand, and with the other bathe



the whole surface of the body and extremities, as represented in the above figure, at the same time administer freely of catnip or other herb tea. This ablution or bathing must be repeated as often as there is an accession or increase of fever, which usually takes place towards evening. This will thoroughly cleanse the surface of all morbid or viscid matter which obstructs perspiration, and while it invites the fluids to the surface, opens the pores of the skin and equalizes the circulation—and which prevents the necessity of abstracting any blood. This course soon diminishes the pulse and fever surprisingly, and secures rest and sleep.

A purgative, as a general rule, may be given every other morning. If the disease is very obstinate, the emetic may occasionally be repeated. The cathartic and the bathing must be regularly persevered in. If there is determination of blood to the head plasters of mustard, Indian meal, and vinegar, combined, must be applied to the feet, and between the shoulders, until the skin become a little red ; also bathe the feet in warm weak ley-water.

The patient may take, as often as he is thirsty, half a tumbler of the

GREAT FEBRIFUGE—COLD SPRING WATER,
also lemonade, if it can be procured, or a little vinegar, sugar, and water combined, and cold toast or barley water. This course regularly persevered in, will cure all cases of bilious remittent fever in our Southern and Western country, unless there is some organic disease of the system. But the disease is usually protracted under the best treatment, and requires perseverance and confidence in the means used.

Beware of making any changes in the above treatment at the suggestion of mineral doctors, or of meddlesome and gossiping old women, or others. And should medical counsel be really required, call in a physician of the

REFORMED SCHOOL OF MEDICINE,
any one of whom will be found more safe and successful than any others in the treatment of these diseases.

See "American Practice and Family Physician," a work which should be in the hands of every family.

CHAPTER IX.

OF DIGESTION.

IN order to repair the waste of their bodies which is continually going on, there is a necessity in all organized beings for nourishing matter to be taken from without, to be added to their system. Vegetables depend on extraneous matter for subsistence, which is taken up by the roots, and distributed by means of the sap-vessels. But the grand characteristic of animals, is their possessing a stomach, a central cavity, into which the nourishing matter is first put, to be from thence taken up into the circulation, and so distributed all over the system. The stomach and bowels constitute the proper digestive apparatus, and several other organs which co-



FIG. 30. THE ŒSOPHAGUS, STOMACH, AND INTESTINES.



f Œsophagus or gullet. *i* The stomach. *h* The pyloric orifice, where the food enters the intestines. *3 3* External rim of the liver. *k* The hepatic duct. *m* Cystic duct. *n* Common duct, formed by the union of the two. *j* Gall-bladder. The arrows represent the intestines, with the course of the food.

operate in various ways to aid it are the assistant digestive apparatus. Besides, we have a set of organs for preparing the food for the stomach, tearing, bruising, grinding and mixing it with fluid that it may be easily swallowed. It is most convenient, though perhaps not most philosophical, to trace these parts successively from the mouth downward; we will, therefore, commence with the parts concerned in digestion, inquire into the nature of the action of swallowing, and trace the food as far as the stomach. From the stomach we will follow it down into the small intestines, see how it is mingled with the bile and the pancreatic juice, and learn how the nourishing parts of it are absorbed and carried into the circulating mass, and how that part which is useless is pushed on, until it is expelled from the body.

MOUTH.

The mouth is a cavity having somewhat the shape of a hemisphere, the flat surface being directed downward and the convexity upward. Its roof is formed by bone; it is shut in at the sides and front by the muscular parts forming the cheeks and lips; below, it is enclosed round about by the lower jaw, and its floor is formed by the tongue. From the back part of the mouth hangs down a conical bag, which leads into the œsophagus or gullet, and the nose communicates with it from above. Hence is the reason that we can breathe equally by the nose or mouth, and that sometimes if we are taken by surprise with a fit of coughing while swallowing, the contents of the throat run out through the nose. In order to prevent this from occurring constantly, there is a curtain placed at the back of the mouth, which we see on looking into a glass, and which rises or falls according to the necessity for its being applied either above or below. A long red tassel hangs down from the centre of it, nearly touching the top of the tongue, which is endowed with great sensibility, and warns the curtain to rise whenever the food comes in contact with it. When food is about to be swallowed, it is rolled about in the mouth and mixed with saliva, till it forms a kind of ball, and when it gets to the back of the mouth, between the arches of the palate, there is felt an irresistible tendency to swallow. The curtain now rises so as to prevent any of it passing up into the nose, the tongue rises against the roof of the mouth, so as to keep it from getting forward again, and the only course left for it is to pass down into the gullet. It is a mistake, however, to suppose that food falls into the stomach, the

fact being that a man can swallow nearly as well when standing on his head as on his feet. This will be understood if we suppose an imaginary division of the gullet into a number of rings. When one ring contracts, the food passes down into the next, then the second contracts, and squeezes it down into the third, while the first being still contracted, prevents it from getting up, and so the process goes on, regularly downward, until the ball arrives at the stomach. And in vomiting, an action takes place precisely the reverse of this, and the food is squeezed up from the stomach into the mouth, although so rapidly as to seem almost instantaneous.

TONGUE.

The tongue is fixed to the back of the chin, and has a muscle arising from this point and radiating through it, forward, upward, and backward, which can protrude the tongue, turn it upward, downward, or to the side, render its surface convex, or hollow to serve for a conduit, as in drinking. There are three pairs of muscles actually forming the substance of the tongue, and not less than six pairs more which can aid in its motions. The whole inner surface of the mouth is lined with a soft mucous membrane, so called because it pours out a mucus from its surface to lubricate it, to protect it, and to assist the food to slide easily through it. The upper surface of the tongue is covered with many delicate papillæ or points in which the nerves of taste end, which vary in appearance in different animals. In the cow, for example, they are much rougher than in man; in the lion they are so rough as to be capable of peeling one's skin off should he attempt to lick it; and in some of the marine animals which swallow living shell-fish, both the tongue and the gullet are covered with thickly set spines, directed backward, to prevent their prey from actually creeping up again.

SALIVARY GLANDS.

Six glands are placed about the mouth for the purpose of supplying saliva to be mixed with the food; two very large ones lie behind the ear, in the hollow between the lower jaw and the temporal bone, so that the motion of eating squeezes out their contents. Their ducts run forward in the cheek, and perforate the mouth opposite the second last tooth in the upper jaw, where with the tongue a small soft projection may be recognised. Two others lie on each side under the tongue, having a common duct, which may be seen opening on the fold of membrane that bridles down the

tongue. This fold, it may be mentioned here, is what produces the appearance called tongue-tied, when too short. The tongue, then, cannot be well put out of the mouth, and the infant cannot nurse conveniently. A little time, however, relaxes the parts.

One or other of the ducts which open below the tongue is subject to become stopped up, and the saliva distends it into a soft swelling, which impedes the motions of the tongue in the actions of speech and mastication. But the most annoying thing connected with the salivary ducts is, when one of those running in the cheek is divided, as by a cut; it is then difficult to heal, and the saliva is constantly running over the cheek. The quantity which is lost in this way in such cases, is very great indeed.

TEETH.

The teeth are the hardest parts in the whole body. In the adult they are thirty-two in number, eight upon each side of each jaw. They are of four different kinds; in front there are, on each side, two incisors or cutting teeth, whose edge is like that of a chisel; next them is one eyetooth, which is pointed; thirdly, there are two small grinders; and lastly, there are three large grinders. The teeth in the two jaws do not exactly meet; the cutting teeth of the upper jaw overlapping those of the under, while the grinders just meet one another. We sometimes, however, see people whose under teeth project beyond their upper, giving a peculiar appearance of length to the lower part of the face.

The crown is that part which appears above the gum, the body is the thick part, and the fangs or roots penetrate down into the socket. A cavity is seen in the body of the tooth, which is occupied by a pulpy substance, containing some blood-vessels and nerves, and a small canal is seen leading from the cavity into each fang, and opening by a minute hole, through which the blood-vessels and nerves enter. The bony part of the tooth which projects above the jaw, and is destined to meet its fellows, and to come in contact with the fluids in the mouth, is protected by the enamel, which is the hardest substance in the body. It is thought not to be an organized substance at all, as no blood or sensibility has been detected in it, so that it seems to be merely a protection, to prevent the remainder of the tooth from being worn. When broken off, it is never replaced, and the tooth of necessity passes into decay.

The structure of the bony part of the tooth is similar to that of bone elsewhere, only it is much harder. Hence, by referring to

the chemical structure of bone, detailed before, it will be understood how the teeth are pained when anything hot or acid is taken into the mouth ; why the patient who is to use acid drops is always directed to suck them through a quill, that they may not come into contact with the teeth, and how the teeth blacken, and are actually dissolved away in persons who are subject to acidity of the stomach. When a hole has formed in a tooth, no pain is felt till the cavity is reached, and the nerve exposed, and then, as almost every one knows by experience, the pain is most excruciating. Sometimes it is relieved by some powerful stimulant dropped into the tooth, as the essential oil of cloves, sometimes by the recently discovered substance called kreosote, which has the property of deadening the nerve, and sometimes the tortured victim is glad to appease the tormentor by destroying the nerve, by the introduction of a hot wire. If the cavity is not large, it ought to be stopped ; an operation which generally succeeds in preserving the tooth for a long time, by excluding the air, and all other agents which could act upon it. This stopping ought to be done with gold leaf, or something of that kind, and by a respectable dentist ; and no one should trust his teeth in the hands of an ignorant dentist. If stopping the tooth does not prevent the recurrence of toothache, the offending member must be removed ; and this last resource should never be deferred so long that the stump requires to be dug out of the jaw ; because then what is a brief though painful operation, is converted into one which is tedious, and often insufferable.

The teeth at first lie deep within the jaw bones, covered, at birth, by the thick gum. Their rudiments at birth are very small. The crown or upper part of the tooth is formed first, then the body, then the enamel is deposited on the crown, and lastly, the fangs grow as the tooth becomes protruded. When the jaw of a new-born child is dissected, a pulp is found for each tooth, like a little stool, into which blood-vessels are seen running, on the top of which the bone is deposited, and after the tooth has attained its shape, the pulpy stool shrinks away almost to nothing, except the small quantity of cellular tissue which conveys the vessels and nerves into the central cavity. The whole tooth is enclosed within a delicate membrane, which becomes ruptured when the tooth bursts forth. The gum of an infant has a sharp line running along it, which serves it to catch anything that is put into its mouth ; and this line becomes broader and flattened, and finally disappears, previous to the eruption of teeth. The order of eruption is generally the following:

First, the two central incisors of the lower jaw appear, then the corresponding ones above. After this, the order is not regularly backwards, for the foremost of the two grinders now appears below, then that above, then the eye-tooth below, then its corresponding one above, and lastly, the second grinder comes through about the end of the second or beginning of the third year. When they do not follow this order, dentition is generally attended with more than usual irritation. The period when the teeth appear varies much. "I know one lady," says Douglas, "who was born with two teeth, as Richard III. says of himself." It is rather early for them to appear at the age of four months, more commonly seven have passed before any signs of uneasiness are discovered, and sometimes even twelve or thirteen. A good deal of constitutional disturbance generally attends teething: the mouth is hot, the gums itchy, and the infant rubs them with anything it can get into its hands. For this purpose nothing is so good as the common ivory ring; all manner of corals and bells should be discarded, as they are apt to injure the mouth, or even to be thrust into the eyes. The bowels are apt to become much deranged, and require constant attention.

From the hardness of the teeth, they are not capable of growing, so as to fill up the increased size of the jaws in after years. Hence we see a growing child come to have spaces left between its teeth, as they are removed from one another by the elongation of the jaw. About the seventh or eighth year, a third grinder on each side of each jaw makes its appearance, which is the first of the permanent teeth, and never changes. When this one is rising above the gums, the central incisors of the under jaw are becoming loose. If a jaw bone be dissected at this period, and its outer part be filed away, a very beautiful preparation is obtained. The first teeth are seen in their places, and the second set are seen deep in the jaw, below, and rather behind them, ready to rise up and supplant them. It is, however, quite a mistake to suppose that the new teeth push out the old; the fact is, that they cannot get up until the old ones be removed. Preparatory to the removal of the old ones, their fangs become absorbed, so that they are not a quarter of an inch in length; whereas, had they been examined some months sooner, they would have been found three times as long. I have a very interesting specimen in my Museum to show the second dentition. It is the cranium or skull of a child, in which is seen the second set of teeth forcing out the first.

Somewhere between the completion of the seventh and eighth years, the second dentition commences. The first permanent grinders appear, and the central incisors fall out and are replaced. In three months more, the lateral incisors follow. In from six to twelve months more, the grinders give way, and after them the eye-teeth. The grinders are succeeded by a new species of teeth, which do not exist in the milk set, called the small grinders. These changes take place about the tenth or eleventh year, and it is not for two or three years more that the second of the permanent grinders makes its appearance. A long interval now succeeds, and the jaw acquires its full proportion, and about the nineteenth or twentieth year the wisdom tooth cuts the gum, but sometimes not till even a later period. Wisdom teeth sometimes appear at thirty. The grinders often give pain in coming through, on account of their broad surfaces meeting with much resistance. The following is a view of the teeth, fangs, and nerves.



STOMACH.

The stomach is a bag of a conical shape; the large end of which lies in the left side of the belly immediately beneath the diaphragm, and the small end at the hollow, which is familiarly known as the pit of the stomach. It is bent besides on account of its passing across the spine; the concave border being directed backwards, and the convex border forward. When the stomach is

FIG. 35. BLOOD-VESSELS OF THE STOMACH.



FIG. 36.



The above figure shows the Liver turned back. The Gall-bladder *a*, Stomach, epiploic menbrum which forms a sort of apron in front, which covers the intestines. It also shows the gastric artery, and *g g g* the epiploic branches, *i* shows the cystic artery.



nearly empty, the convex border hangs downwards, and it rises forwards, producing sometimes a painful feeling. This is most felt by persons who are troubled with indigestion after taking food. In such persons, if one finger be laid on the epigastrium and struck with one of the other hand, it will sound like a drum, in consequence of the quantity of air which is contained in the stomach. The œsophagus or gullet enters the great or left end of the stomach, and the pylorus or small intestine commences at its lesser or right end. These two orifices are upon the same level, so that the food does not run out of the stomach, but can only be retained by the contraction of its coats. These are muscular, as indeed are the coats of the whole intestinal canal, and are particularly strong at the smaller end, where they form a ring, which contracts and completely closes the communication between the stomach and intestines. The stomach is lined with a velvety mucous membrane, similar to and continuous with that which lines the mouth and gullet. This membrane is full of minute blood-vessels, from which a mucous fluid is poured, which serves at once to mingle with the food and assist its digestion, and to protect the coats of the stomach from injury. Accordingly, when any irritating substance is swallowed, mucus is immediately poured out, which envelopes it, and prevents, as far as possible, the evil consequences which might ensue.

GASTRIC JUICE.

Besides the mucous, another fluid is poured into the stomach by its coats, which is called the gastric juice. This is a clear ropy fluid, of a saltish taste, possessing the power of dissolving all substances which are fit for food. It has no effect, however, on the living stomach; but we often find, on opening persons who have died suddenly, with a quantity of the gastric juice in the stomach, and no food, that the dead stomach itself has been dissolved, and that a large irregular opening exists in its back part.

After a meal, the stomach becomes agitated by a constant succession of gradual contractions, which turn the food gently back again, churning it and mixing it all well together, so that it acquires the appearance of so much porridge or gruel, the different aliments that have been swallowed becoming so blended as to form a homogeneous mass of a greyish color. It is turned backward and forward for three hours or more, until the delicate sense which resides in the orifice leading into the intestines is satisfied that it is fit to pass further. The con-

stricted ring then opens to let it through, and it passes into the commencement of the bowels. But such is the delicacy of perception with which the orifice of the stomach is endowed, that it will not let undigested food pass, until it has been rolled about in the stomach for many hours, and presented to it and rejected many successive times. Indeed it often refuses to allow such food to pass at all, and then there is no help for it but that it be ejected summarily by vomiting.

Let us now inquire into that part of the process of digestion which goes on in the stomach.

DIGESTION.

In this organ the first of those changes takes place which fits the extraneous matter swallowed as food, for being received into the circulation of the fluids of the living body, and for becoming a component part of the animal. For now, the gastric juice, acting on the semifluid mass, quickly dissolves out the digestible part, and entering into union with it, produces a new, thick, and turbid fluid, which has been called chyme. The alimentary mass changes its sensible and chemical properties, by an operation peculiarly animal, or depending on the existence of life. The change is not strictly chemical, for we do not find anything like it going on out of the living body. Animal or vegetable matters in any vessel possessing the heat and moisture of the stomach, would quickly fall into fermentation, and become sour, but the living properties of the stomach prevent this. No acid is formed in the stomach in the healthy state; but when it is weak, and its nervous action is damaged, then the symptoms which announce the diminished power are the extrication of gas, and formation of acid, with oppression and uneasy sensations. The contents of the stomach consist of air, partly swallowed, partly formed in it, of the mucous secretion from its coats, and of the chyme. The stomach having been stimulated by fulness, by wind, and still more by the peculiar irritation of the food undergoing digestion, the muscular coat is brought into action, and the contents of the stomach delivered into the commencement of the small intestine (duodenum).

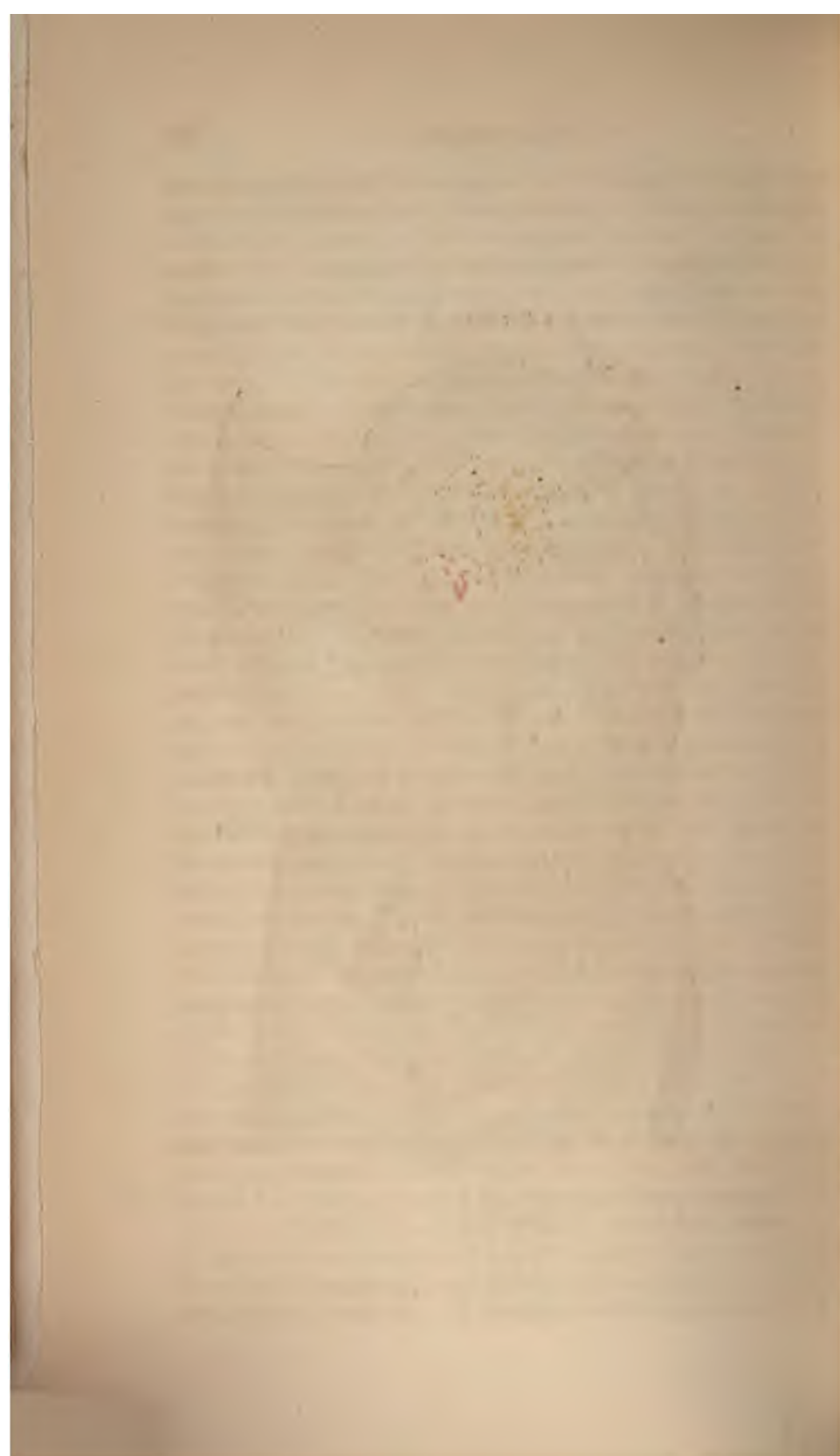
HUNGER.

We are solicited to take food by the uneasy sensation of hunger, a sense which appears placed as a safeguard lest the body should be permitted to wear out. In the artificial state of society in which

FIG. 31. CONTENTS OF THE ABDOMEN AFTER REMOVAL OF THE INTESTINES.



L L L L Liver. G Gall-bladder. P P Pancreas. S Spleen. K K Kidneys. B Bladder. U U Ureters. R Rectum. A Aorta. V V Vena cava.



we live, where regular hours are appointed for meals, so that one shall succeed before the interval after the preceding shall have been so long as to produce pain, scarcely any one knows what hunger really is, except by some self-inflicted abstinence. Yet though unaccustomed to be felt by us, there is an unpleasant sensation produced by want of food, amounting at first only to a feeling of emptiness, lassitude, and indescribable uneasiness, but gradually getting worse until it end in actual pain, as if the inward parts were all on fire. There was a time when it was thought that the internal surfaces of the empty stomach rubbing against one another produced hunger, and hence arose the vulgar phrase of "taking the wrinkles out of your stomach," by satisfying the appetite; but that is too mechanical an explanation. If the sensation proceeded merely from such rubbing of the coats of the stomach, food swallowed would be more likely to aggravate than to assuage the gnawing of hunger; to excite the action of the stomach would be to excite the appetite; and an irritable stomach would be attended with an insatiable desire for food. Something more than mere emptiness is required to produce hunger. By some of the ancients, hunger was referred to the weight of the liver dragging down the empty stomach, forgetting that the liver is as heavy, and will drag as much when the stomach is full as when it is empty. By others, with more probability, it is supposed to proceed from the action of the gastric fluid on the nerves in the coats of the stomach. Hunger is, like thirst, a *sense* placed as a safeguard calling for what is necessary for the system, and depending on the general state of the body. Morbid craving may proceed from many causes; a tape-worm in the bowels has occasioned voracious appetite, and ardent spirits and high seasoning excite it even when the stomach is full; but natural hunger has always a reference to the wants of the general system.

THIRST.

Thirst is a sensation seated in the tongue, throat, gullet, and stomach. It depends on the state of the membrane which lines these parts, and of the fluids which naturally moisten it, and may arise either from a deficiency of that fluid, or from an acrid state of it. It would appear to be placed as a monitor calling for the dilution of the fluids by drink, when they have been exhausted by perspiration and the fatigue of the body, or when the contents of the stomach require to be made more fluid, the more easily to suffer

the necessary changes of digestion. The feeling of thirst, when carried to an extreme, is said to be much harder to bear than that of hunger, and the most dreadful picture is given of it in some accounts of shipwreck, particularly in that published of the horrible calamities endured by the crew of the French frigate, the *Medusa*, on the coast of Africa.

The changes which take place on the tongue, in consequence of the state of the stomach and intestines, depend on its intimate connexion with these organs, and the nervous sympathy which is established between them. The state of the tongue, the loose or viscid state of the throat, the secretion of the saliva, the softness or huskiness of the voice, are all influenced by the state of the stomach. We attend more to the effects on the tongue than to any of the rest, because it is more accessible, and affords us a sort of index to the state of the stomach. In health, it is clean, red, and moist; in indigestion, it is white; in disorders of the bowels, it is more or less thickly furred; after excess in wine or spirits, it is dry and chopped; and in typhoid cases of fever, it becomes quite black.

A great many absurd experiments have been performed, with the view of elucidating the nature of digestion, on the one hand, and the digestibility of various kinds of aliments, on the other. The most remarkable are those of Spallanzani, a celebrated physiologist of Modena. At the time when he entered upon his researches, it was thought that this phenomenon was only a species of trituration, and that the chyme was merely the food bruised till reduced to pulp: but Spallanzani showed this not to be the case. He caused birds to swallow articles of food contained in tubes, and little metallic boxes, the walls of which were pierced with holes, so as to preserve these substances from all friction, but not to withdraw them from the action of the liquids contained in the stomach, and he found that digestion took place as under ordinary circumstances. He, therefore, justly concluded, that the gastric juice must be the principal cause of the chymification of food, and to be more completely assured, he had recourse to very ingenious experiments. He made crows and other birds swallow little sponges attached to a thread, by means of which he withdrew these bodies from the stomach after they had remained there for some minutes, and had imbibed the liquids contained in this cavity. Thus he procured a considerable quantity of the gastric juice, which he placed in small vessels with the food suitably divided: he took care at the same time to raise

the temperature, so as to imitate as nearly as possible the circumstances under which chymification takes place ; and at the end of some hours he found the alimentary mass, submitted to this artificial digestion, transformed into a pulpy matter, similar in all respects to that which would have been formed in the stomach by a natural digestion ; thereby proving that the action of the gastric juice upon the food is the principal cause of its transformation into chyme.

A very curious case has recently occurred by which immediate access was had to the living stomach, and the experiments which were performed have been published by their author, Dr. Beaumont, of Plattsburgh, in this State.

A young man, of a good constitution, when eighteen years of age, was accidentally wounded in June, 1822, by a musket loaded with buckshot. The shot tore away a piece of his left side, about a hand's-breadth in extent, making a hole into his stomach. For seventeen days everything that was taken by the mouth passed out at the hole ; but after that period, by means of properly adapted bandages, the food was enabled to be retained. The wound gradually diminished until it became of the size and nearly of the appearance of the natural anus ; and about a year and a half after the accident, the lining membrane of the stomach came to form a valve which prevented anything from running out, although the finger, or a tea-spoon, or a tube could be readily introduced. By two years after the accident, he had completely recovered his health and strength, and Dr. Beaumont conceived the idea of making use of the extraordinary opportunity thus put into his hands of examining into the nature of digestion.

When the stomach was empty and at rest, the interior of its cavity could be examined to the depth of five or six inches, and food and drink could be seen entering it, through the ring at the entry of the gullet. The solvent power of the gastric juice was ascertained in the most conclusive manner. Almost every variety of aliment, whether animal or vegetable, when submitted to the action of the fluid taken from the stomach when fasting, and kept at a temperature of about 100°, was found to become reduced to a paste in a few hours, which resembled very nearly the contents of the stomach after the same kinds of aliment had been eaten. The rapidity with which substances were dissolved by the gastric fluid out of the body, was always in proportion to the purity of the fluid, and the tenderness and state of minute division of the substances

submitted to its action. Milk and the white of an egg were invariably found to become first curdled by the fluid, and then dissolved.

The periods required for the solution of various substances in the gastric juice out of the body, varied as follows:—Sago and tapioca, boiled, were completely dissolved in about three hours and a quarter; fresh bread, in about four hours and a half; milk, in about the same time as bread; calf's-foot jelly, in about four hours and three quarters; soft boiled eggs, in six hours and a half—hard boiled, two hours longer; oysters, raw and entire, seven hours and a half, stewed, eight hours and a half; beefsteak, in eight hours; boiled beef, in nine hours and a half; boiled mutton, and raw pork, in eight hours and a half; beef suet, boiled, in twelve hours; mutton suet, boiled, in ten hours; cream, in twenty-five hours and a half; olive oil, in sixty hours. In these experiments the gastric juice employed was about eight times the quantity of the substance to be dissolved. It will be seen from these experiments, that fat and oily food were among the articles which presented the greatest resistance to the solvent powers of the gastric fluid; and this Dr. Beaumont found to be the case in the stomach as well as out of it. Some of his experiments indicate that the digestibility of this sort of food is facilitated by a slight admixture of bile with the gastric juice, and that very generally, when aliment containing fat is eaten, bile is found in the cavity of the stomach.

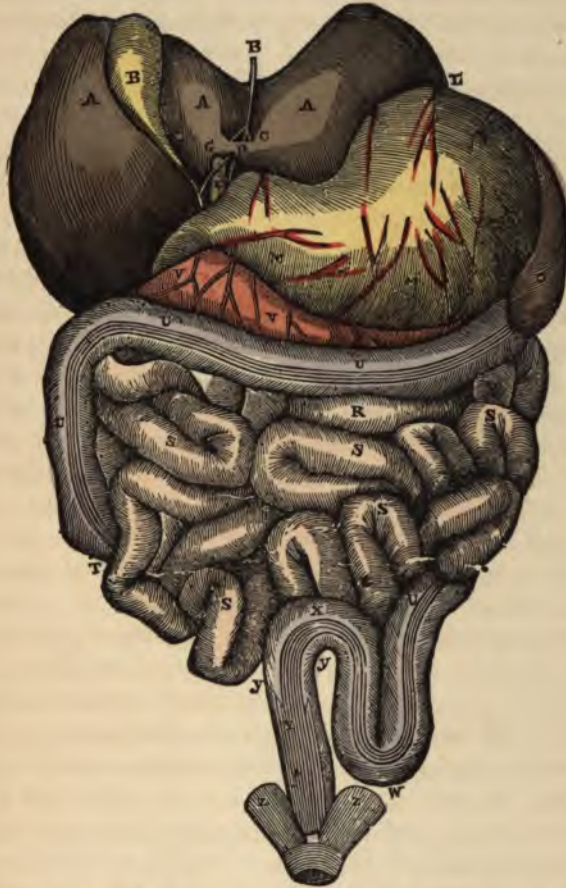
I will now transcribe the conclusions which Dr. Beaumont has deduced from his experiments on his patient.

“The ordinary time required for the complete digestion of the food received into the stomach, in a healthy state of that organ, is generally three hours and a half. The facility of digestion is modified, however, by many circumstances, as the peculiar nature of individuals, habit, the nature of the food, and the manner in which it is prepared: minuteness of division, and tenderness of fibre, would appear to be the two great essentials for the speedy and easy digestion of the aliment.

“Albumen (white of eggs), if swallowed either raw or very slightly coagulated, is perhaps as rapidly digested as any article of diet we possess. If perfectly hardened by heat, and swallowed in large solid pieces, it experiences a very protracted digestion. Fibrin (red muscular flesh) and jelly are affected in the same way; if tender and finely divided, they are disposed of readily; if in large solid masses, digestion is proportionably retarded.”

Animal fat is invariably, and very quickly rendered fluid by the

FIG. 32. THE INTESTINAL CANAL.



A A A Under surface of the liver. B Gall-bladder. E Hepatic Artery. M M Stomach. V V Pancreas. O Spleen. U U U U Colon. T Cæcum and Appendix Vermiformis. W Sigmoid flexure of the Colon. X Y Rectum. Z Z Muscles of the Rectum. P Sphincter Muscle of the Rectum. R Duodenum. S S S S S Small intestines.



heat of the stomach, and, with any species of oily food, resists for a long time the action of the digestive organ and its fluids. It has already been noticed above, that this sort of food generally requires an admixture of bile to render it soluble.

“Bulk is perhaps nearly as necessary to the articles of diet as the nutrient principle. They should be so managed, that the one of these qualities should be in proportion to the other. Too highly nutritive diet is probably as fatal to the prolongation of life and health, as that which contains an insufficient quantity of nourishment.”

A commencing state of putrefaction, sufficient to render the muscular fibre slightly tender, was found to increase the digestibility of most kinds of flesh. This is a practice which every housekeeper in this country adheres to, though without knowing the principle on which it is founded.

Some kinds of vegetable aliment, generally speaking, he discovered to be slower and more difficult of digestion than animal. Its solution in the stomach is greatly influenced, however, by division and tenderness of fibre. Raw vegetables often pass through the stomach in an undigested state, while other food is retained and fully digested.

The thorough mastication of the food is essential to healthy digestion. “If aliment,” remarks the author, “in large masses be introduced into the stomach, though the gastric juice may act upon its surface, digestion will proceed so slowly, that putrefactive changes will be likely to commence in its substance before it will become completely dissolved. Besides, the stomach will not retain undigested masses for a long time, without suffering great disturbance.” Consequently, eating too fast impedes digestion, by introducing food into the stomach in a state unprepared for the actions of that organ and of its fluids. Also, if food be swallowed too rapidly, more will in general be taken into the stomach, before the sense of hunger is allayed, than can be digested with ease.

Overloading the stomach with food is invariably found to interfere with the regular process of digestion; a portion remaining for a long time undigested. This very soon becomes rancid, or runs into the acetous fermentation; and if not rejected by vomiting, causes pain and irritation of the stomach, and other distressing symptoms; or if it be permitted to pass into the intestines, its presence almost invariably gives rise to colic, flatulence, or even more dangerous affections.

Condiments, as spices, though they may at first excite the action of a debilitated stomach, yet, when used habitually, never fail to produce debility of that organ, and in this manner impede digestion. Salt, pepper, and vinegar, are exceptions, and are not obnoxious to this charge when used in moderation. They both assist digestion, —vinegar, by rendering muscular substance more tender—and both, by producing a fluid having some analogy to the gastric juice. Spirituous, and probably all artificial drinks, cider excepted, impede more or less the digestive process; some more so than others, but none can claim exemption from the general charge. Even tea and coffee, the common beverages of all classes of people, have a tendency to debilitate the digestive organs.

After a full meal, rest should be taken for at least an hour. After that, moderate exercise rather aids digestion, but severe and fatiguing exertion always impedes its performance. An experiment was made by a medical man on a couple of dogs of the same litter, and of equal health. After giving them a good dinner of flesh, one was taken out and hunted for four hours, while the other was permitted to lie down and sleep. They were then both killed; the hunted dog had the meat in his stomach quite undigested, the idle one had it quite gone. The lesson is a most instructive one.

The intestines form a membranous tube nearly six times the length of the body, about five-sixths of this length belonging to the small intestines, and about one sixth to the large. The small intestines are the canals in which the chyme is received from the stomach; and when digestion is completed, the large serve chiefly as receptacles for the refuse which is to be expelled from the body.

In the figure the small intestine is seen commencing from the smaller or right extremity of the stomach, passing to the right side, where it lies close below the liver, and receives from it the gall ducts; then turning downward and to the left, where it receives the ducts from the pancreas; then twisting and forming a great number of convolutions which lie chiefly in the middle of the belly, round about the navel, and finally terminate in the large intestine in the right side. The whole intestine is lined with a continuation of the velvety membrane which lines the stomach, and which is constantly moistened by a mucous secretion. The thickness of the gut is formed of muscular fibres, arranged in two layers, the outer layer being longitudinal, and the internal layer circular. The effect of the gradual contraction of these fibres is to squeeze the food downward; and if the belly of an animal newly killed be opened, the

FIG. 29. THE INTERNAL PARTS.

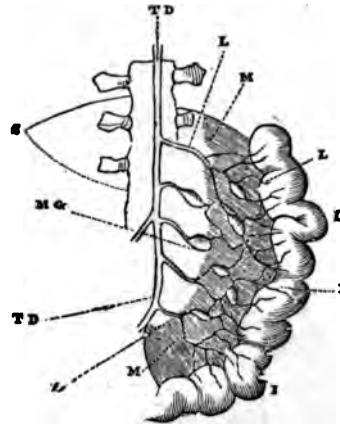


H The heart. R L Right Lung. L L Left Lung. D D Diaphragm, which separates the chest from the bowels. Livr. Liver. Stm. Stomach. G Gall-bladder. I I I Intestines.



owels are seen moving in the manner of a bunch of earthworms, whence the name of *vermicular motion*, which has been given to it. The gall ducts enter the small intestine about six inches after it leaves the stomach, and the moment the bile mingles with the chyme, a chemical change takes place, and the separation of the nutritious parts from the refuse begins to go on. A creamy-looking white fluid, called *chyle*, appears on the surface of the food next to the mucous membrane, and it is sucked up by an infinity of small vessels called the *absorbents*. The use of the great length of the alimentary canal is, that every part of the food may be turned about, and successively be presented to the mouths of these vessels, so as to have its nourishing particles fully removed. The food becomes gradually thicker and drier as it passes down, and is stained of a yellow color, from the admixture of bile, but it still remains perfectly sweet, and without any unpleasant smell, until it gets into the large intestines, where it puts on the character of *fæces* or useless matter.

Intestines, Lacteals, and Mesentery Glands.



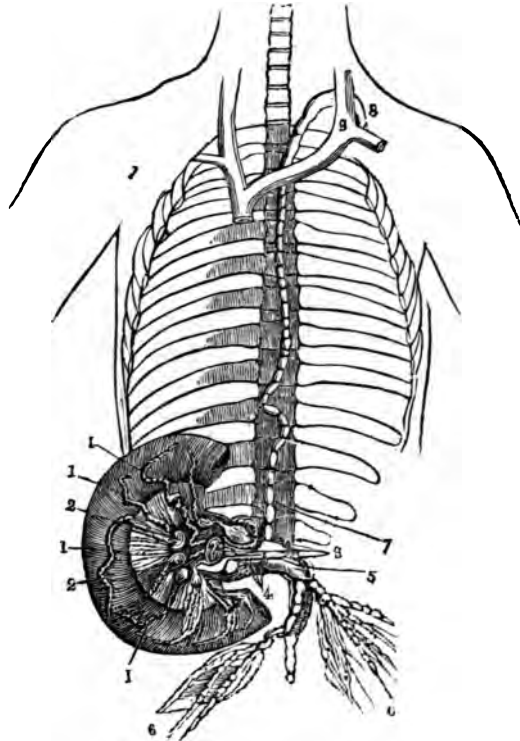
T D T D, the chyle duct; L, lacteals; M G, mesenteric glands, several of which are here represented; S, spinal column. The folding structure of the intestines is here well represented.

The large intestine is seen in the figure to commence by a blind end, into the side of which the small intestine opens. A valve is here placed, to prevent the regurgitation of the *fæcal* matter into the small bowels. A curious appendage, about the size of a large earth worm, is seen hanging from the end of the commencement of the large gut, which in man is merely rudimentary. In purely *graminivorous* animals, the intestines are much longer than in man, and have several of these contrivances, for delaying the less nutri-

tious food which they subsist upon, until all its useful particles can be absorbed. In carnivorous animals again, the intestinal canal is short, because the food is so highly nutritious, that digestion is very quickly completed. From this pouch, then, the great gut ascends in the right side, crosses over the belly below the stomach, descends in the left side, forms a twist like the letter S, and then turns into the pelvis to open outwardly at the anus. It is called the colon.

It has already been stated, that the nourishing part of the food, the chyle, is absorbed from the intestines by an infinity of small vessels, having a close affinity to veins. Their structure is very like that of veins, and they are provided with valves, which prevent

Lacteals, Mesentery Glands, and Thoracic Duct, running up the spine and emptying its contents, the purified chyle, into the left subclavian vein, and thus mixing with the blood.



1. Lacteal vessels emerging from the mucous surface of the intestines.
2. First order of mesenteric glands.
3. Second order of mesenteric glands.
4. The great trunks of the lacteals, emerging from the mesenteric glands, and pouring their contents into—
5. The receptacle of the chyle.
6. The great trunks of the lymphatic or general absorbent system, terminating in the receptacle of the chyle.
7. The thoracic duct.
8. Termination of the thoracic duct at—
9. The angle formed by the union of the internal jugular vein with the subclavian vein.

the fluid which they convey from taking a retrograde course. They are not more than the thirtieth of an inch in diameter, and are so transparent, that they are not visible when empty. If a dog be killed about two hours after a full meal, these vessels will be seen in great numbers arising from the bowels, and filled with a white milky fluid, whence they receive the name of lacteals. These vessels unite at the right side of the spine into a trunk about the size of a goose-quill, which at length pours its contents, containing all the nourishment of the body, into the great vein of the upper part of the body, near where it joins the breast, as may be clearly seen in the preceding figure.

There is another set of vessels, of precisely the same kind, called lymphatics, which are very difficult to discover in dissection, because the fluid which they convey is not milky, but transparent lymph. These arise from every part of the body, and have for their office to remove the worn out parts, which are no longer serviceable, and which are to be replaced by new deposits from the blood. The lymph is poured into the duct which has been spoken of in the preceding paragraph, and is mixed with the blood in the veins, so that afterwards it may be expelled from the body through the lungs, the liver, the kidneys, and the skin. The lymphatic and lacteal vessels are included under the common name of absorbents. They both pass through glands, which are roundish bodies about the size of hazel nuts, in which the absorbents subdivide and reunite, apparently for the purpose of mixing thoroughly the lymph and chyle together. For a beautiful view of the lymphatics, see steel engraving in front of this work.

The absorbent vessels and glands are very subject to disease in those individuals who are of a scrofulous temperament. The glands are very liable to enlarge, inflame, burst, and suppurate, particularly in the neck, arm-pits, and groins, and produce sores which are very tedious in healing. Sometimes in scrofulous children the larger branches from the intestines become obstructed before they arrive at the main duct, so that all the food they eat (and they generally have voracious appetites) never does them any good, because it never gets into the circulation. Such children are generally small and puny, with sharp thin faces, and large tumid bellies. Some years ago, a person by the name of Calvin Edson was exhibited in this city, called the "living skeleton," in consequence of having been reduced so low. His weight, I think, was about forty pounds. It proceeded from a disease or obstruction in the thoracic

duct, which proved fatal, ascertained by a post mortem examination. This fact shows conclusively the course of the chyle, the only nutritious portion of the food.

The whole of the contents of the belly are covered with a thin shining membrane, called the peritoneum, which also lines the boundary walls of that cavity. It is of the same nature as the membrane which lines the chest and covers the lungs, and that which surrounds the heart. Its smooth polished surface is evidently intended to permit the constant gentle motions of the bowels to go on easily, without our being at all sensible of them. Its inner surface is kept moist by a thin liquid, the evaporation of which is the reason why the body of an animal newly killed, is seen to smoke when opened and exposed to the air. When this fluid is poured out in too great quantity, the bag of the peritoneum becomes distended with it, and constitutes the disease called dropsy. It is customary by physicians generally to tap the patient, that is, to insert a small tube with a sharp point into the cavity of the belly, so as to permit the water to run out. But this operation affords only temporary relief. This membrane is exceedingly liable to become inflamed, and when inflammation does come on, it runs a very rapid course, and often proves speedily fatal. It is from this inflammation that many of those females sink, who perish after childbirth.

Let us now devote a page or two to a notice of the diseases of the alimentary canal.

The stomach is rarely the seat of inflammation. It is so accustomed to have all manner of things indiscriminately, and often recklessly poured into it, that it would not be fit for its place in the body if it were too easily inflamed. Many poisons, however, such as vitriol, arsenic, mercury, and corrosive sublimate, produce death by exciting violent inflammation of the stomach. The stomach is nevertheless very subject to a low degree of inflammation or irritation, which gives great uneasiness to its possessor. There are many, particularly among the female population, and those not in the lowest ranks, who can scarcely swallow any food, without its being succeeded by a feeling of distension, and a sense of uneasiness, not amounting to actual pain, but as distressing as if it were, producing headache, giddiness, coldness of the feet, and of the surface generally, acidity, with eructations of gas, and sometimes the bringing up of a mouthful of fluid. These annoyances last till the three or four hours have passed, during which the food remains in the stomach. Complaints of this kind are exceedingly difficult to remove without pro-

per attention to diet. The food introduced must be as easily digestible as possible. It is not easy to lay down any rule for this, although the account given above of the digestibility of different substances will furnish some data; but the stomachs of those troubled with indigestion are most capricious, and we sometimes see them reject anything simple, and evince what we would consider the most extraordinary predilections. Mild laxatives, tonics, bitters, &c., all may take their turns as assistant remedies. Pustules brought out on the stomach by our irritating plaster are often most beneficial.

One habit, and a very important one too, and which is much neglected, and often induces this and other complaints of the digestive organs, is a neglect of proper mastication or chewing our food sufficiently. Tyrone Power, in his *Travels in America*, speaking of the hasty manner in which the Americans eat, thus remarks:—“*They dart their food with the rapidity of a wolf!*” Fowler, in his work on *Physiology*, thus remarks on this subject:—

HOW TO EAT; OR MASTICATION.

“Our food once selected, the next question is, how shall it be eaten? With teeth, of course, never with the stomach. Nature forbids our throwing it into its receptacle as with a shovel. By rendering its only passage way small, she literally *compels* us to deposit it in small parcels. She has also furnished us with a mouth, set all around with two rows of teeth, which fit exactly upon each other, and are every way adapted to crushing our food to atoms. Nor can we swallow our food without its being more or less chewed.

To persuade as well as to compel such mastication, nature has rendered it highly *pleasurable*. Instead of food being tasteless, she has given it a far more delicious flavor than all the spices of India could impart. Yet man does not know how to enjoy a tithe of the gustatory pleasure she has appended to eating. Not one in thousands know how to eat! Not that all do not know how to eat enough, yet few know how to eat *little* enough. All know how to eat fast enough, but very few know how to eat slowly enough. And strange as it may seem, few know how even to *chew*, simple, easy, and natural as this process is! Nine hundred and ninety-nine in every thousand eat mostly with their *stomachs*, instead of with their teeth! One would think that this poor slave had to perform two or three times its wonted task, simply to digest the enormous quantities of heterogeneous compounds forced upon it,

instead of being compelled, in addition, to do what the teeth should previously have done. Yet this practice is universal. Is eating indeed so very onerous a task that it should thus be hurried and slighted? Most men pitch and shovel in their food in great hunks, mouthful following mouthful, thick and fast, which they give twist or two, hit a crack or two, and poke down 'in a jiffy;' eating in five minutes as much as would take a full hour to eat well. Americans generally treat eating as they treat impertinent customers—dismiss it without ceremony for something appertaining to business. Yet, than the due *feeding* of the body, what is more important? Of course the time occupied in eating should correspond. Besides, how can we expect to enjoy the gustatory pleasure nature has associated with eating, unless we take ample time for such enjoyment? Instead of dispatching our meals to get to business, we should dispatch business, and eat at perfect leisure. We should never sit down to the table in a hurry, or till we have dismissed from the mind all idea that we have anything else on hand, and should then eat as leisurely as if time and tide waited for us. The ox and horse eat as quietly as though their food was their all. Only swine guttle down their food. And well they may; for their tastes are so coarse that they eat what is most loathsome, and derive their pleasure from quantity mainly. Shall man imitate the swine? Shall he bolt his food and hurry off to business, and thus forego gustatory enjoyment, and also shorten his days; thereby curtailing that very business he is so anxious to do? Take ample time to eat well, and you will live probably twice as long, and this protraction of life will enable you to do more business. Eating fast is the worst possible stroke of business policy you can adopt. Let business stand, while you eat with the utmost deliberation. Let *nothing* hurry you to, or at, or from the table. Make eating a *paramount* business, and the acquisition of wealth a trifling toy in comparison. No one should deposit an ordinary meal in less than an hour. How foolish to cram it down with swinish voracity in five minutes! Yet sapheads often make quick eating their *boast*.

Though the loss of gustatory enjoyment—that most delightful repast—consequent on eating fast, is great and irreparable, yet this is one of its smallest and lightest evils. It breaks down the stomach, and thus unmans and diseases the entire system. No other cause, if even a combination of causes, is as prolific of dyspepsia and all its dire array of evils, as this. We have not overrated the importance of a due selection of food, yet its proper mastication is

far more important. Eat slowly and masticate thoroughly, and the kind of food eaten, however noxious, will rarely break down the stomach, but eating the best selection of food fast will ruin almost any stomach. How can the gastric juice penetrate the food unless it is mashed fine? Food deposited in chunks defies its solvent power for a long time, meanwhile irritating and weakening its power; whereas, if it were well crushed before it entered the stomach, this juice could penetrate or get hold of it, and digest it before fermentation occurred."

DISEASES OF THE STOMACH AND BOWELS.

Cancer is a disease which attacks the stomach after the middle period of life is passed; it consists in a thickening of the coats of the stomach, forming a growth which sometimes can be felt even from the outside. It produces the most distressing symptoms, burning heat, constant craving for food and drink, with inability to retain them, and at length the patient dies.

Inflammation of the bowels takes place after exposure to cold, or the swallowing improper food. Some pain marks its approach, and generally obstinate costiveness, and requires active treatment.

A not uncommon complaint connected with the belly, particularly among the laboring population, is rupture. This consists in a portion of the bowels being forced out from their natural position, through some weak point in the walls of the belly, forming a swelling, covered by the skin. This swelling requires to be pressed up in a recumbent position, and means used to keep it from coming down again. The apparatus used is generally a truss, consisting of a steel spring covered with leather, which goes round the waist, having a pad at one end, for making pressure on the weak part. Sometimes the rupture becomes strangulated, that is to say, it swells so that it cannot be replaced, and then it would mortify, so that death would be the inevitable consequence, were not means adopted by which the stricture is dilated, and the protruded parts returned.

In speaking of morbid states of the stomach and bowels, I should not omit to mention the curious but simple means by which poisons are now easily withdrawn from the stomach. A gum-elastic tube, about the thickness of one's little finger, is passed down the throat into the stomach, and a brass pump which holds about half a pint, is attached to the end of it. Two or three pints of warm water are now thrown into the stomach, to dilute the matters there, and the whole contents are then easily withdrawn. The syringe can act either as

a sucking or forcing pump, so that by fresh supplies of water the stomach can be thoroughly washed out. In extreme cases, this may be resorted to, but in general, even after violent poisons have been taken to commit suicide, as laudanum, &c., large doses of an emetic power are sufficient to remove the contents of the stomach.

PHYSIOLOGICAL INFERENCES.

The digestive organs are very subject to derangement and disease, such as indigestion, costiveness, &c. This proceeds from various causes, such as error in diet, too great a quantity of food, or an improper quality, and that not sufficiently masticated, and swallowed like the hog—too greedily; the use and abuse of ardent spirits, tobacco, warm fat animal food, warm drinks, as tea and coffee, calomel, blue pill, Thompsonian “courses” of medicine, consisting of *lobelia*, *capsicum*, &c., over excitement of the brain, want of exercise, &c. The stomach is a long period losing its tone, and requires a long time to restore it. The remedies consist in abstaining from all those exciting causes, and adopting a proper course of diet, regimen, and medicine. The object should be to restore the lost or enfeebled tone of the digestive organs. A mild cathartic may be taken occasionally, and the bowels kept regular by the Anti-Dyspeptic Pills. To strengthen the stomach, create an appetite, and to remove that horrid depression and despondency which renders life a burden, nothing is better than the *Restorative Wine Bitters*. Bathing the surface daily with tepid or cold ley water, followed by friction with a coarse towel. In general, a light vegetable diet is preferable, and particularly bread made with unbolted wheat flour, and which should be at least one day old. For more particular information on complaints of the digestive organs, see Reformed Practice.

Here let us devote a small space to the inquiry, What is the natural and best food for a healthy state of the stomach, animal or vegetable?

Says Fowler—“Since, therefore, the form of the human teeth creedes from that of the carnivora far more, even, than that of the monkey and ourang-outang species, which are confessedly not carnivorous, therefore human teeth were not made to eat meat. What proof can more conclusively attest anything than this establishes the natural diet of man herbivorous?”

To this conclusion nearly every sound physiologist has been impelled, by this dental, and other kindred arguments. The im-

mortal Linnæus sums up this argument thus : 'Fruits and esculent vegetables constitute his most suitable food.' Cuvier, the highest authority on this point, sums it up thus : 'The natural food of man, therefore, judging from his structure, appears to consist of fruits, roots, and other succulent parts of vegetables ; and his hands offer him every facility for gathering them. His short and moderately strong jaws on the one hand, and his cuspidati being equal in length to the remaining teeth, and his tubercular molares on the other, would allow him neither to feed on grass nor devour flesh, were these aliments not prepared by cooking.'

That distinguished physiologist, Professor Lawrence, sums up an elaborate argument on this point as follows : 'The teeth of man have not the slightest resemblance to those of carnivorous animals, except that their enamel is confined to the external surface. He possesses, indeed, teeth called canine, but they do not exceed the level of the others, and are obviously unsuited for the purposes which the corresponding teeth execute in carnivorous animals.' 'Whether, therefore, we consider the teeth and jaws, or the immediate instruments of digestion, the human structure closely resembles that of the simiæ or monkeys, all of which, in their natural state, are completely frugivorous.'

Dr. Thomas Bell, in his 'Physiological Observations on the natural food of man, deduced from the character of his teeth,' declares, that 'every fact connected with human organization goes to prove that man was originally formed a frugivorous animal.' Cullen and Lamb took similar ground, and the Abbé Galani ascribed all crimes to animal destruction. Pope protests against 'kitchens sprinkled with blood,' and insists that animal food engenders crime. Plutarch tells us that Pythagoras ate no pork, and wondered what first 'led man to eat carcass.'

These conclusions, however unpopular, have been extorted from every rigid physiologist who has ever examined this subject ; and are confirmed by the length of the alimentary canal, which is short in the carnivora, long in the herbivora, and long in man—about six times the length of his body.

These two arguments, derived from the structure of the teeth and alimentary canal, of themselves completely establish the dietetic character of man to be vegetable ; and, taken in connexion with those converging principles already adduced and yet in reserve, establish this anti-flesh-eating argument as a fundamental ordinance of nature.

SLAUGHTER-HOUSE CRUELITIES, PESTS, AND NUISANCES.

Humanity condemns, in the strongest manner, those unheard-of cruelties perpetrated on animals while killing them, in order to render their meat less bloody, and more tender. To keep the feet of calves and sheep tied together, in the most painful posture possible—tumble them into carts on top of one another—bang them about as if they were so many boxes and barrels—keep them for days together without a morsel of food, and then, after all this living death, to hang them up by the hind feet, puncture a vein in the neck, and let them hang in this excruciating torture, faint from loss of blood and struggling for life, yet enduring all the agonies of death, for six or eight hours;—meanwhile pelting them, to beat out the blood and render the meat tender, with might and main, so that every blow extorts a horrid groan, till tardy death at length ends their sufferings with their lives—and all perpetrated on helpless, unoffending brutes—is a little worse than anything else except human murder; yet it is but the legitimate fruits of flesh-eating. Hear the piteous wail of these wretched animals, on their passage from the farmyard to the slaughter-house; see their upturned eyes rolling in agony; witness the desperate struggles, and hear the terrible bellowings of the frantic bullock who apprehends his fate, as he is drawn up to the fatal bull-ring; or even look at the awful expression of all amputated heads, as seen in market, or carried through the streets, and then say whether the slaughtering of animals is not a perfect **OUTRAGE** on every feeling of humanity—every sentiment of right!” And yet all this is practised by great professors of religion. Zealots! What hypocrites!

In concluding this chapter on the digestive organs, I deem it not irrelevant or out of place to advert to the common and injurious effect of mercury in the stomach and system generally, which I will do in the language of Dr. S. Chapman, of Philadelphia, late professor in the Medical University there. When I delivered my popular lectures in that city, the venerable old gentleman sent me, through his son, his respects, and some of his writings, with a very friendly invitation to visit him.

THE USE OF POISONS, CALOMEL, AND DEPLETIONS.

The very principle upon which they act, is their destruction of life. Taken in health, they induce sickness; much more aggravate it. And their reputation for curing diseases is due mainly to abstinence from food, perspiration, and emptying the stomach, all of

which can be effected by processes entirely harmless. Their effect upon the teeth alone brands them with unequivocal condemnation; for whatever injures them first disorders the stomach. Their decay foretokens incipient dyspepsia. Hence, since they are always impaired by these medicines—and whoever has taken poison is a living witness of this fact—they of course always enfeeble the stomach.

Narrowing down our observation to that popular medicine CALOMEL. It powerfully stimulates the liver, but stimulates by POISONING it. Hence liver affections almost always follow its administration—always except when both stomach and liver are extra powerful. Dyspepsia follows its use almost as surely as sunrise daylight, because induced thereby. Let observation, the more extensive the better, pronounce the verdict. Language can never adequately portray its ravages on health and life. On this point hear Professor Chapman, of Philadelphia, to his class:—

"GENTLEMEN:—If you could see what I almost daily see in my private practice in this city, persons from the South, in the very last stages of wretched existence, emaciated to a skeleton, with both tables of the skull almost completely perforated in many places, the nose half gone, with rotten jaws, ulcerated throats, breaths most pestiferous more intolerable than poisonous upas, limbs racked with the pains of the Inquisition, minds as imbecile as the puling babe, a grievous burden to themselves and a disgusting spectacle to others, you would exclaim as I have often done, 'O! the lamentable want of science that dictates the abuse (use) of that noxious drug calomel!' Gentlemen, it is a disgraceful reproach to the profession of medicine, it is quackery, horrid, unwarranted murderous quackery. What merit do gentlemen of the South flatter themselves they possess by being able to salivate a patient? Cannot the veriest fool in Christendom salivate—give calomel? But I will ask another question. Who can stop its career a will, after it has taken the reins in its own DESTRUCTIVE AND UNGOVERNABLE HANDS? He who, for an ordinary cause, resigns the fate of his patient to mercury, is a vile enemy to the sick; and if he is tolerably popular, will in one successful season have paved the way for the business of life; for he has enough to do ever afterwards to stop the mercurial breach of the constitutions of his dilapidated patients. He has thrown himself in fearful proximity to death, and has now to fight him at arm's-length as long as the patient maintains a miserable existence."

Dr. Graham, of Edinburgh, in speaking of mercurial medicines, says:—

"They affect the human constitution in a peculiar manner, taking, so to speak, an iron grasp of all its systems, and penetrating even to the bones, by which they not only change the healthy action of its vessels, and general structure, but greatly impair and destroy its energies; so that their abuse is rarely overcome. When the tone of the stomach, intestines, or nervous system generally, has been once injured by this mineral, according to my experience (and I have paid considerable attention to the subject), it could seldom afterwards be restored. I have seen many persons to whom it has been largely given for the removal of different complaints, who, before they took it, knew not what indigestion and nervousness meant, only by the description of others; but they have since become acquainted with both, for they now

constantly complain of weakness and irritability of the digestive organs, of frequent lowness of spirits and impaired strength ; all of which, it appears to me, they will ever be sensible of. Instances of this description abound. Many of the victims of this practice are aware of this origin of their permanent indisposition, and many more, who are at present unconscious of it, might here find, upon investigation, a sufficient cause for their sleepless nights and miserable days. We have often had every benevolent feeling called into painful exercise, upon viewing patients already exhausted by protracted illness, groaning under the accumulated miseries of an active course of mercury, and by this for ever deprived of perfect restoration. A barbarous practice, the inconsistency, folly, and injury of which no words can sufficiently describe."

This is the testimony of its FRIENDS—of distinguished members of the medical FACULTY—and is true of the PRINCIPLE on which calomel and all mineral poisons act. And the more virulent the poison, the worse. Those who take them may recover, yet it will be in SPITE of both disease and medicine. And their recovery will be slow, and constitutions impaired.

"But," retorts one, "I took calomel, arsenic, quinine, and other condensed poisons, was immediately relieved, and more robust afterwards than before." Aye, but how long did you remain so ? In a few months your stomach became impaired, and various aches, to which you were before a stranger, afflicted you. Still, all are quite welcome to swallow all the rank poisons they please, but for one, however sick, I should rely on other remedies, particularly perspiration.

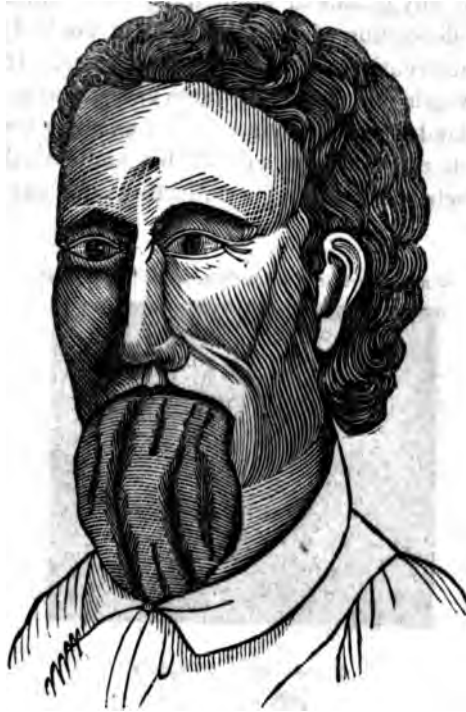
Scarcely less detrimental than these poisons is that draining of the life's blood which generally accompanies it. It does not extract the disease, or at least only in proportion as it withdraws life itself, and repeated depletion diverts the vital energies from brain and muscle to the extra manufacture of blood.

A summary of these medicinal principles shows that we place far less reliance on medicines, even vegetable, as restorative agents, than on physiological prescriptions. Obey the laws of health, and we need not be sick, and when sick a return to this obedience is the most direct road to health. Still the existence of medicines shows that they should be taken. Yet why in the present highly condensed form ? Why not in that diluted form in which we find them in nature ? In short, why not take them along with our food ?*

The following figure represents the appearance of a person under the influence of mercury, in this city, to whom the author was called in consultation. The tongue protruded from the mouth, and



prevented him from speaking; it was enormously enlarged and burst open, jaws swollen, &c., &c. Over one hundred leeches had been applied to reduce the inflammation.



CHAPTER X.

SECRETION AND EXCRETION.

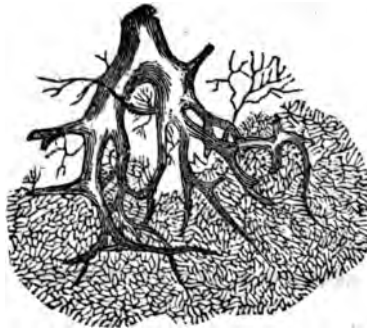
WE have seen, in the preceding chapters, that there are arrangements for circulating the blood and for keeping it pure. The great object in these arrangements seems to be, that the substances required in the different parts of the system may be separated from the blood in a proper state. There is a class of bodies, known by the name of glands, whose office appears to be principally to form different secretions. Thus, the liver is a gland, which is said to

secrete (separate) bile : the salivary glands, we have seen, secrete saliva ; and so on with others. It would be a mistake, however, to suppose that secretion is performed only by glands, for thin membranes, without any glandular structure, produce numerous secretions ; and the deposition of the solid parts of the body takes place without the intervention of anything like glands. It seems to be the capillary vessels, themselves, in these cases, that are employed ; and even in glands, however minutely we examine their structure, there can be detected almost nothing but endless subdivisions of circulating vessels, and ducts for collecting and carrying off the secreted fluid.

Intimate structure of a Composite Gland [the Parotid].



Representation of a Kidney



The liver is the largest gland in the body. We have seen that it secretes the bile, which probably serves important purposes in digestion. The numerous ducts of the liver unite and form one large duct, called the hepatic duct, from which the bile passes into the common duct, or into the gall-bladder, to be poured, when required, into the upper part of the intestinal canal. The bile is an

alkaline fluid, which contains, besides other substances, a peculiar resinous principle. Unlike other secretions, it is formed from the venous blood. The whole veins of the stomach and intestines, instead of going directly to the right side of the heart, first unite to form one great trunk (*vena portæ*), which divides, like an artery, in the substance of the liver; and these branches, by which the bile is secreted, again unite, and join the veins going to the heart in the ordinary way. In some species the veins going to the kidneys have a similar distribution. From this, and for various other reasons, it is strongly conjectured that the liver assists the lungs in purifying the venous blood, by depriving it of a portion of its carbon; and, accordingly, we always notice the liver larger in animals in proportion as the activity of their lungs diminishes. The carbon unites with oxygen, and forms carbonic acid in the lungs, but it seems to escape from the liver in union with another gas called hydrogen, forming the resinous and other principles of the bile. We have before stated that less oxygen is consumed, and of course less carbonic acid is produced, when the temperature is high, than when it is low. Hence, probably, a chief cause of the diseases of the liver we are liable to in warm climates; for if less carbon be given off at the lungs, more will have to be secreted by the liver; and any part required to do more than its ordinary duty, is liable to become deranged. It is thought about six or eight ounces of bile are ordinarily secreted daily. Another analogous substance called *urea*, is secreted by the kidneys, which are glands that also probably assist in purifying the blood. It is probable that both the resinous matter in the bile, and the urea in the urine, exist ready formed in the blood, and are merely separated by their respective glands; as, when the kidneys of dogs have been taken away, urea has been detected in the blood, which could not be the case if the kidneys formed it. It sometimes happens, especially in drunkards, that one or both of these glands become diseased, and are incapable of separating the peculiar fluids mentioned; and then these, being retained in the system, act as poisons, producing insensibility and death. In the case of the liver, this forms one cause of jaundice; but jaundice is more commonly caused by an obstruction to the flow of the bile through its ducts. The passage of gall-stones (which are only bile solidified) from the gall-bladder through the gall or common ducts, is a common cause of obstruction. When the substance of the liver becomes diseased, the flow of blood through its

veins is also often obstructed, and this very generally gives rise to the liver complaint and dropsy.

What has been said must suffice in regard to the larger glands; smaller ones are scattered in almost every part of the body. The whole extent of the intestinal canal, and of the skin, is found to be studded with bodies having a glandular structure, and producing secretions.

Some secretions are evidently produced only in particular emergencies, as we see with the increased secretion of bony matter when a limb is broken; other secretions are uncommon in their nature, as in the case of such fishes as the torpedo or of the firefly, the former of which can produce at pleasure powerful electrical discharges, and the latter a substance that gives out light; while in other instances, again, secretions become unusual in their situation, or of a morbid kind. Of a secretion unusual in its situation, a curious instance occurred some years ago in France. A woman who was suckling had the secretion of milk transferred from her breasts to one of her lower extremities, from which her child continued to be supplied. Of morbid secretions we have examples in ossification of the valves of the heart, in consumption, in cancerous, brainy, and other tumors, and, unfortunately, in too many other cases.

The secretions are much influenced by our mental states. Every one has felt the flow of saliva increased from savory odors, or the flow of tears from distressing feelings. A cheerful state of mind is peculiarly favorable to the proper performance of the function of secretion; and we therefore learn how important it is to avoid such things as distract, or agitate, or harass us; and yet how unavoidable!

As to the agent which produces or directs the different secretions, we have no very accurate information. In one instance, at least, Dr. W. Philip found that its place could be supplied by galvanism. He cut the principal nerves going to the stomach, and the secretion of gastric juice was completely stopped; but the secretion was restored when a galvanic pile was made to communicate with the lower extremities of the nerves. Of late years it has been discovered that the operations of galvanism are much more various and subtle than was formerly supposed, and it therefore seems not unreasonable to conjecture that its agency may be important also in secretion.

GENERAL SUMMARY OF THE EXCRETING PROCESSES.

We have now passed in review the various processes, by which the products of the disintegration or the animal tissues are carried off; and we have seen that the necessity for their removal is much more urgent than for their replacement. A cold-blooded animal may subsist for some weeks, or even months, without a fresh supply of food; the waste of its tissues being so small, if it remain in a state of rest, as to be quite compatible with the continuance of its life; and a warm-blooded animal may live for many days, or even weeks, provided that it has in its body a store of fat sufficient to keep up its heat by the combusive process. But in either case, if the exhalation of carbonic acid by the lungs, the elimination of biliary matter by the liver, the separation of urea or uric acid by the kidneys, or the withdrawal of putrescent matter by the intestinal glandulæ, be completely checked, a fatal result speedily ensues;—more speedily in warm-blooded animals than in those which cannot sustain a high independent temperature, on account of the greater proneness to decomposition in the bodies of the former, than in those of the latter;—and more speedily in the latter, when their bodies are kept at an elevated temperature by the warmth of the surrounding medium, than when the degree of heat is so low, that there is little proneness to spontaneous change in the substance of their bodies.

It may be taken as a general principle, in regard to the excreting processes (including respiration), that they have a three-fold purpose;—in the first place, to carry off the *normal* results of the waste or disintegration of the solid tissues, and of the decomposition of the fluids;—in the second place, to draw off the superfluous alimentary matter, which, though received into the circulating current, is not converted into solid tissue, in consequence of the want of demand for it;—and in the third place, to carry off the *abnormal* products, which occasionally result from irregular or morbid changes in the system. • Thus by the lungs are excreted a large amount of carbon, and some hydrogen, resulting from the disintegration of the tissues, especially the nervous and muscular; the same elements, in animals that take in a large proportion of farinaceous or oleaginous aliment, may be derived immediately from the food, without any previous conversion into solid tissue; and there can be little doubt that the respiratory function is also an important means of purifying the blood from various deleterious matters, either introduced from without (such as narcotic poisons), or generated within

the body (such as the poison of fever*). And it is important to bear this last circumstance in mind; since it enables us to understand how, if time be given, the system *freed itself* from such noxious substances; and points out the duty of the medical attendant to be rather that of supporting the powers of the body by judiciously devised means, and of aiding the elimination of the morbid matter through the lungs and skin by a copious supply of pure air, than of interfering more actively to promote that which Nature is already effecting in the most advantageous manner.

[Suitable views of the liver will be found in Linnæus' Colored Plates, page 86, and of the kidneys, at page 88.]

CHAPTER XI.

EXHALATION AND ABSORPTION.

By exhalation is meant the escape of some portion of the contents of the blood-vessels (generally little altered), probably through pores in their sides. When a fluid, colored with vermilion, is injected into the blood-vessels of a dead animal, the fluid portion will pass out of them, and is said to be exhaled, while the vermilion is retained; or when a solution of phosphorus is thrown into the veins of a living animal, in a few seconds fumes of phosphorous acid are given off from its lungs. By absorption is meant the removal of the soft or hard parts of the body, or of substances placed in contact with these parts. When a fat person becomes lean, or the fluid in a dropsical person's belly has disappeared, the fat and the fluid are said to have been absorbed.

The three most important exhaling and absorbing surfaces, are the intestinal canal, the lungs, and the skin; but these processes are active also in the chest, belly, and other cavities. We have already explained the structure of the intestinal canal and lungs, and the skin will be treated of at the close of this chapter, so that it will be necessary at present only to say that the skin has a thin

* There is strong reason to believe that, in many instances, a small amount of poisonous matter introduced from without, in the form of a contagion or miasm, may process resembling fermentation, to the production of a large quantity of similar substances in the animal fluids.

outer covering, called the cuticle, or epidermis (the part raised by blistering), which has no feeling, and little vitality; and another thicker part underneath, called the true skin (the part which tanners convert into leather), which is plentifully supplied with nerves, blood-vessels, &c.

From what has been said, it will be seen that the mechanism of exhalation is very simple, the fluid merely passing through the sides of its vessels. In every part of the system an active absorption is carried on by the same means, the fluid removed merely passing through the sides of the veins, to be carried off by the internal current. It was at one time supposed that absorption was exclusively carried on by a system of vessels, which received the name of absorbents; but this is now known to be quite incorrect. Allusion has already been made to one portion of these absorbent vessels connected with digestion, which are called lacteals. Similar vessels in other parts of the body receive the name of lymphatics, from a fluid called lymph, which they convey; and in their course towards the thoracic duct, in which they almost all terminate, they pass through glandular bodies, found in numbers in the hams, groins, armpits, on the sides of the neck, &c. It is these glands about the neck that so often swell and inflame when there is disease of the gums, or eruptions on the head, or when there exists a highly scrofulous habit of body.

The veins appear to take up all fluid matters indiscriminately that are brought in contact with them; the lacteals take up principally (if not solely) chyle; the office of the lymphatics seems to be chiefly to mould the different parts of the body into their proper forms, and the lymph contained in them is probably the removed animal matters, which, it is supposed, may undergo some changes while passing through the lymphatics and their glands, that render them fit to be mingled with the blood. From the late researches of Fohmann, Panizza, and Lanth, it would appear that the lymphatics commence by minute plexuses, and that these at their origin do not communicate with the arteries and veins, but begin by shut extremities. In the frog, and in some other reptiles, there have been discovered parts, connected with the lymphatics, that pulsate irregularly, like hearts. The frog has four of these, which seem to be used for propelling the lymph.

Absorption and exhalation, in a healthy state, generally balance each other, so that a full-grown person's weight, notwithstanding the quantity of food consumed, will frequently for years vary only

a few pounds. The conditions which promote the one generally impede the other. When the body is saturated with fluid, absorption goes on slowly; but exhalation, under the same circumstances, takes place rapidly. M. Majendie found that when a quantity of water was thrown into an animal's veins, absorption was either much impeded, or altogether suspended; and, on the other hand, when the blood-vessels were partly emptied by bleeding, the effects of a poison, that usually showed themselves at the end of the second minute, were distinctly perceived before the thirtieth second. A frog, kept for some time previously in dry air, when its legs are immersed in water, will in a short time absorb nearly its own weight of the fluid.

We have already spoken of the absorbing powers of the intestinal canal. The next in importance, as an absorbing surface for external substances, is the lungs, and, of course, the matters absorbed are generally conveyed in the form of vapor. When a fluid poison, however, is injected into the windpipe, it acts with fearful rapidity. It is through this surface that substances diffused in the atmosphere usually produce their effects on the system. The vapor of turpentine, breathed along with the air of a room, may be detected in the urine within a short time afterwards, and the concentrated vapor of such poisons as prussic acid will instantly kill an animal if inhaled. The various poisons which produce fever, measles, small-pox, and other infectious disorders, are in this way introduced into the body, the smallest quantity frequently sufficing for this purpose. We can conceive the small quantity of the poison required, when we notice that the least particle of the matter of the small-pox, placed in a scratch on the skin, gives rise to the same disease. In proof of the action of poisons, when inhaled by the lungs, the following facts may be stated.

M. Majendie contrived some experiments, in which dogs were confined in the upper part of a barrel, the lower part being filled with putrifying animal substances, which were separated from the dogs by a grating. Confinement in this situation, from the absorption of the putrid effluvia, produced death generally about the tenth day. The animals took food, and were even lively, but became much emaciated before death. The same physiologist produced symptoms exactly resembling those of yellow fever, by injecting a few drops of putrid water into the veins of dogs.

A nurse in one of the Dublin hospitals, apparently in excellent health, was desired by the physician to assist a patient, laboring

under fever, to turn in bed. Being very feeble, he endeavored to support himself by placing his arms round the nurse's neck, when she suddenly drew back, struck by the offensive odor from his person, and exclaiming that she had caught fever. She instantly became cold, pale, and ghastly, and, appearing about to faint, had to be removed to her room. Malignant fever, of a very severe description, succeeded, and lasted for thirteen days.

In the island of St. Lucia, in the West Indies, two boatmen were employed hauling their canoe up on the beach, close to a dangerous swamp, when they perceived a small cloud of vapor approaching, which gradually enveloped them. One immediately fell down insensible, and the other was so much affected as to be unable to render him any assistance. The vapor soon passed away, and both men recovered so far as to be able to walk home. The one most affected, however, was seized with fever, and died within forty hours afterwards.

Repeated instances occur in the West Indies of, twenty or thirty workmen being employed in cutting drains or canals in these infectious swamps, nine out of ten of whom will be seized in a few days with the most dangerous forms of tropical fever. Chiefly from these pestilential fevers, also, the probability of life to Europeans in the West Indies is very low. It appears, from the most accurate army returns, that a young man's chance of life, which in this country would probably be about forty years, is reduced in Jamaica to about seven years.

In marshy districts, the poison diffused in the atmosphere operates with intensity chiefly after sunset, and produces dreadfully fatal fevers and agues. We see also, in the natives of these districts, the effects which the slow operation of the poison produces on the health. Their appearance in highly infected districts is miserable in the extreme. Stunted in their growth, with swollen bellies, stupid expression, and jaundiced complexions, they linger out a miserable existence, and can anywhere, at a glance, be recognised. Happily their sufferings terminate life quickly. It is a curious circumstance that these poisons generally lie latent or inactive in the body for some time. In the fevers of this country, the latent period may vary from a few days to some weeks; while in marsh fever, a person will often have left the infected district, six, twelve, or more months, before he is seized with it.

We have entered into these details in order that it may be seen, 1st, that unnecessary exposure to air infected with the poison of

fever, is both improper and highly dangerous ; and, 2dly, to show how important to health is pure air, attention to cleanliness, and the removal of all putrifying animal and vegetable matters from the vicinity of our dwellings. In a very filthy part of Constantinople, called the Jews' quarter, the plague constantly prevails more or less, and the same may be said of typhus fever in some confined and dirty parts of London, Edinburgh, Glasgow, and most other large cities.

The city of New York, to the disgrace of its citizens, particularly the corporation, is the most filthy of any other, with all its advantages of Croton water. Both animal and vegetable substances are suffered to accumulate, with pools of dirty, putrid, and noxious water ; slaughter and fat-houses are tolerated, which are not only extremely offensive and nuisances, but sufficient to spread infectious diseases, and would, no doubt, were our city not surrounded with the preventative of *salt water*. There are a sufficient number of men who would consider it a favor to keep our streets clean and healthy, even if they received one half of the sum which is expended to promote the interests of political parties only in the items of banners, processions, feasts, &c.

In man, the absorbing powers of the skin are much more limited than those of the lungs. When the cuticle is entire, indeed, it appears to absorb almost none, unless the substance be rubbed on it with force, or be of a very irritating nature. When the cuticle is removed, however, it absorbs readily. This is the reason why the most virulent poisons can be handled with impunity, only while the cuticle is entire. Students often suffer severely from this cause, when, in opening dead bodies, they accidentally puncture or cut themselves, even in the slightest degree. The poison introduced by the cut part inflames it dreadfully, and death not unfrequently occurs within a few days. It is for the same reason that a slight scratch must be made through the cuticle before a child can be inoculated. Have we not abundant means and facilities to acquire all the knowledge necessary to treat and cure both physical and surgical diseases, without robbing the graveyards, and resorting to that revolting and dangerous practice of *dissections* ? Should any one doubt it, let him pay a visit to my ANATOMICAL MUSEUM, and if he is unprejudiced, he will be convinced of it. Here every part of the human system is demonstrated with extraordinary minuteness and accuracy, in *natural plaster* and *wax*, imitating most perfectly every one of the original organs. Besides, all this may be studied

without the offensive effluvia of the dissecting-room, and at all seasons. This great improvement constitutes a new era in favor of MEDICAL REFORM, and must be identified with it, and must be carried out as soon as circumstances permit.

CHAPTER XII.

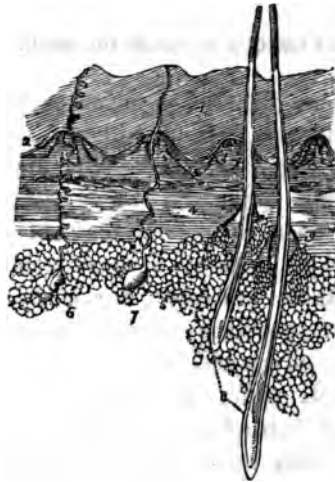
CUTANEOUS SYSTEM OR SKIN.

THE glands which are disposed in the substance of the skin, and in the walls of the intestinal canal, although individually minute, make up by their aggregation an excreting apparatus of no mean importance. The skin is the seat of two processes in particular; one of which is destined to free the blood of a large quantity of fluid; and the other to draw off a considerable amount of solid matter. To effect these processes, we meet with two distinct classes of glands in its substance; the sudoriparous or sweat-glands, and the sebaceous or oil-glands. They are both formed, however, upon the same simple plan; and can frequently be distinguished only by the nature of their secreted product.

The perspiratory form small oval or globular masses, situated just beneath the skin, in almost every part of the surface of the body. Each is formed by the convolution of a single tube; which thence runs towards the surface as the efferent duct, making numerous spiral turns in its passage through the skin, and penetrating the epidermis rather obliquely, so that its orifice is covered by a sort of little valve of scarf-skin, which is lifted up as the fluid issues from it. The convoluted knot, of which the gland consists, is copiously supplied with blood-vessels. On the palm of the hand, the sole of the foot, and the extremities of the fingers, the apertures of the perspiratory ducts are visible to the naked eye, being situated at regular distances along the little ridges of papillæ, and giving to the latter the appearance of being crossed by transverse lines. According to Wilson, as many as 3528 of these glands exist in a square inch of surface on the palm of the hand; and as every tube, when straightened out, is about a quarter of an inch in length, it follows that in a square inch of skin from the palm of the

hand there exists a length of tube equal to 882 inches, or $73\frac{1}{2}$ feet. The number in other parts of the skin is sometimes greater, but generally less than this; and according to Mr. Wilson, about 2800 inches may be taken as the average number of pores in each square inch throughout the body. Now the number of square inches of surface, in a man of ordinary stature, is about 2500; the number of pores, therefore, is *seven millions*; and the number of inches of perspiratory tubing would thus be 1,750,000; or 145,833 feet; or 48,611 yards; or nearly 28 miles.

The Anatomy of the Skin.



1. The epidermis, showing the oblique laminae of which it is composed, and the disposition of the ridges upon its surface. 2. The rete mucosum or deep layer of the epidermis. 3. Two of the quadrilateral papillary clumps, such as are seen in the palm of the hand or sole of the foot; they are composed of minute conical papillae. 4. The deep layer of the cutis, the corium. 5. Adipose cells. 6. A sudoriparous gland with its spiral duct, such as is seen in the palm of the hand or sole of the foot. 7. Another sudoriparous gland with a straighter duct, such as is seen in the scalp. 8. Two hairs from the scalp, enclosed in their follicles; their relative depth in the skin is preserved. 9. A pair of sebaceous glands, opening by short ducts into the follicle of the hair.

From this extensive system of glands, a secretion of watery fluid is continually taking place; and a considerable amount of solid matter also is drawn off by the epithelium-cells that line the tubes. Under ordinary circumstances, the fluid is carried off in the state of vapor, forming the *insensible* perspiration; and it is only when its amount is considerably increased, or when the surrounding air is already so loaded with moisture as to be incapable of receiving more, that the fluid remains in the form of *sensible* perspiration upon the surface of the skin. It is difficult to estimate the proportion of solid matter contained in this secretion; partly on account of the

great variations in the amount of fluid eliminated by the sudoriparous glands, which are governed by the temperature of the skin; and partly because the secretion can scarcely be collected for analysis, free from the sebaceous and other matters which accumulate on the surface of the skin. According to Anselmino it varies from $\frac{1}{2}$ to $1\frac{1}{2}$ per cent. ; and consists in part of lactic acid, to which the acid reaction and sour smell of the secretion are due ; in part of a proteine compound, which is probably furnished by the epithelium cells that line the tubes ; and in part of saline matters, directly proceeding from the serum of the blood. Sanctorius proved that three-fourths of all taken into the system passed off by the skin.

The amount of fluid excreted from the skin is almost entirely dependent upon the *temperature* of the surrounding medium ; being increased with its rise, and diminished with its fall. The *object* of this variation is very evident ; being the regulation of the temperature of the body. When the surface is exposed to a high degree of external heat, the increased amount of fluid set free from the perspiratory glands becomes the means of keeping down its own temperature ; for this fluid is then carried off in a state of vapor, as fast as it is set free ; and in its change of form, it withdraws a large quantity of caloric from the surface. But if the hot atmosphere be already loaded with vapor, this cooling power cannot be exerted ; the temperature of the body is raised, and death supervenes, if the experiment be long continued. The *cause* of the increased secretion is probably to be looked for in the increased determination of blood to the skin, which takes place under the stimulus of heat. The entire loss by exhalation from the lungs and skin, during the twenty-four hours, seems to average a little above two pounds. In a warm dry atmosphere, however, it has been found to rise to as much as five pounds ; whilst in a cold damp one, it may be lowered to one and two-thirds of a pound. Of this quantity, the pulmonary exhalation is usually somewhat less than one-third, and the cutaneous somewhat more than two-thirds ; but when the quantity of fluid lost is unusually great the increase must be chiefly in the cutaneous exhalation ; since the amount of exhalation from the lungs is not influenced by the external temperature, but only by the degree in which the surrounding air is previously saturated with moisture.

The variations in the amount of fluid set free by cutaneous and pulmonary exhalation, are counterbalanced by the regulating action of the kidney ; which allows a larger proportion of water to be

strained off in a liquid state from the blood-vessels, as the exhalation is less,—and vice versâ. The cutaneous and urinary excretions seem to be vicarious, not merely in regard to the amount of fluid which they carry off from the blood, but also in respect to the solid matter which they eliminate from it. It appears that at least one hundred grains of effete azotized matter are daily thrown off from the skin; and any cause which checks this excretion, must increase the labor of the kidneys, or produce an accumulation of noxious matter in the blood. Hence attention to the functions of the skin, at all times a matter of great importance, is peculiarly required in the treatment of febrile diseases; and it will be often found that no means is so useful in removing the lithic acid deposit in diseases of the kidneys, as copious alkaline ablution and friction of the skin, combined with exercise. The exhalant action of the skin is completely checked by the application of an *impermeable varnish*, the effect is not (as might be anticipated) an elevation of the temperature of the body. A partial suppression by which means gives rise to febrile symptoms, and there is an escape of the albuminous part of the blood into the urinary tubes, in consequence (it would appear) of the increased determination which then takes place towards the kidneys. These facts are interesting, as throwing light upon the febrile disturbance which accompanies those febrile and cutaneous diseases that affect the whole surface of the skin at once, and interfere with its functions; and as accounting also for the albumen which frequently manifests itself during their progress, especially in fever.

The exhaling powers of both the skin and the lungs are very considerable. In winter, we notice the watery vapor coming from the lungs condensed by the cold air; in summer, we see how much fluid escapes from the skin in the form of perspiration. Independently of this, however, from thirty to sixty ounces of watery fluid are calculated to pass off daily from the skin in the form of insensible perspiration. This insensible perspiration may be seen to be condensed, when the point of the finger is moved along the surface of a looking-glass, at about the distance of an eighth of an inch, and also when we handle any polished steel instrument; or still more decisively when the arm is confined in a glass jar; or when the body is viewed by a microscope in a state of free perspiration. It is then seen enveloped in a cloud or vapor; this comes in contact with the cold of the atmosphere, which condenses it, when it falls down in the form of water or sweat, being then heavier than

the air. Rain is, no doubt, caused in the same manner. Dr. Smith has performed some interesting experiments on the subject of exhalation, from the skin and lungs jointly. Eight workmen in the Phoenix Gas-works, London (where they must work hard, and be exposed to a high temperature at the same time), were weighed before going to work, and immediately afterwards. In one experiment, in November, they continued to work for an hour and a quarter, and the greatest loss sustained by any one man was two pounds fifteen ounces. In another experiment, in the same month, one man lost four pounds three ounces in three quarters of an hour; and in an experiment of the same kind, in June, one man lost no less than five pounds two ounces in an hour and ten minutes.

We shall conclude this chapter by stating a few other circumstances connected with the structure and functions of the skin. We have mentioned that the external layer of the skin is called the cuticle. M. Breschet, a French author, who has very carefully investigated the structure of the skin, considers the cuticle to be of the same nature as the horny matter which forms the nails, the hairs, feathers, horns, &c., of animals. It is secreted by particular organs, and when intended to be colored, it is mixed with coloring matter (which also is secreted by distinct organs) while in a fluid state. The arrangement of the cuticle, in different parts of the human body, is well worthy of attention. Where feeling is to be exercised, it is thin and delicate; over the joints it is lax and movable; on the palms of the hands and soles of the feet, even in the infant, it is thick and hard, and these properties are greatly increased by constant use. Simple as this last provision may appear, it seems doubtful whether the want of it would not have interfered materially with the exercise of many of our most useful arts.

Between the cuticle and the true skin, formerly mentioned as the part of animals that is tanned, is found the layer that gives the color to the different varieties of the human species, &c. (*rete mucosum*.) In Europeans it is generally of a light color, in Negroes it is black, and in other races it is intermediate, or of other shades. The color of the Negro does not depend on the blackening of the cuticle by the sun, for his cuticle is seen to be as transparent as an European's when raised by a blister; and we observe, also, that the secretion of the black coloring matter does not take place in the Negro child until a day or two after birth. The change of color in the human family, I have no doubt, took place at the confounding of the languages at the tower of Babel. It is all nonsense to suppose that

the climate is sufficient to make the difference of color in the human family. Is it capable of making the nose flat, skin jet black, and hair like wool? The idea is ridiculous. I see no theory so rational as that which supposes that the different colors of nature, almost as many shades and varieties as dialects, were formed at the very time their language was altered or confounded, viz. at the tower of Babel, and for the very wise reason that, as the people could not converse together, their colors were correspondingly changed.

The *cutis*, or true skin, is the third and most important layer. Besides its uses already referred to, it has a very large supply of blood sent to it; is a surface of great sensibility, intimately sympathizing with the internal organs; and, from its exposed situation and extent, is peculiarly liable to be affected by external influences. Perhaps no other surface in the body is so much concerned in the production of internal inflammatory disorders, and perhaps the agents that above all others tend to produce these, are the various degrees, and especially the sudden applications, of *heat* and *cold*. When heat is applied suddenly and extensively, so as to give rise to a burn or scald, the heart's action is frequently extinguished within a few hours, even although the burn, in any one portion, is altogether superficial and unimportant. Mr. John Hunter gives a striking proof of the effects produced by a sudden change of temperature on the skin. He took an eel, which was swimming in water a little above 30 degrees, and plunged it into water about 60 degrees, a temperature in which it habitually lives with ease. The sudden change, however, gave such a check to its system, that the animal instantly expired.* In these cases the effect seems to be produced principally through the agency of the nervous system; but when the application of cold produces its injurious effects, the blood that is forced, by the constricted vessels, from the surface, upon the internal parts, overloads them, and impedes the due performance of their functions. Hence the indispensable importance of recalling it back to the surface instead of abstracting. This theory overturns the old allopathic doctrine of blood-letting. When the body is exposed for some time to a great degree of cold, the tendency to sleep becomes almost irresistible. Under these circumstances, to

* Says a writer—"We lately met with a case exemplifying the effect of sudden change of temperature. A person who had been treading snow in an ice-house felt his feet uncommonly cold. To remedy this, he plunged them into water somewhat heated. The consequence was, the little toe of one foot and part of the great toe of the other mortified, and had to be cut off."

use the words of Dr. Solander, quoted by Captain Cook, "whoever sits down will sleep, and whoever sleeps will wake no more." These words were used by Dr. Solander during an excursion in Terra del Fuego, with Sir Joseph Banks and nine other individuals, when the cold was intense. Notwithstanding Dr. Solander gave the precaution, he was the first to feel the effects of the cold, and his companions were obliged to yield so far to his entreaties as to allow him to sleep for five minutes. With the utmost difficulty he was aroused. Two black servants also slept, and perished. Exposure to a lesser degree of cold acts differently. Every one knows the power of cold draughts of air, of cold or damp feet, the wearing of damp clothes, or sleeping in damp sheets, in giving rise to inflammations, even in persons whose surface has a vigorous circulation, and is therefore not easily chilled. When the circulation on the surface is languid, these causes act with tenfold force; and hence in all such constitutions it is of the utmost moment, 1st, that the skin should at all seasons be protected from sudden chills by warm (the best are flannels) coverings; and, 2dly, that bathing, a proper diet, and all other means that give permanent vigor to the circulation should be specially attended to. Under all circumstances, indeed, frequently cleansing the skin, by removing noxious excretions, and allowing the proper exercise of its functions, has a much more important influence on health than is generally imagined.

[Good views of the lymphatic vessels will be found in Lizars' Colored Plates, page 99, and of the skin, at page 82 of the same. Connected with the subject of the skin, the teacher may introduce some instructive lessons on the five varieties of the human species and their distribution. We have found that these lessons are rendered much more impressive by having drawings of these varieties, and also a skeleton map of the globe, of a large size (say six feet by four), colored so as to indicate their different localities. Thus, the European, or Caucasian, may be left white, the Mongolian colored yellow, the American red, the Malay brown, and the Ethiopian black. The drawings, and the requisite information as to localities in making this map, will be found in the latter part of Lawrence's Lectures on Man, 8vo. edition.]

CHAPTER XIII.

THE ABSORBENT SYSTEM

COMPREHENDS 1st, the vessels which convey the lymph and chyle into the veins, and 2dly, the enlargements which occur in their course, called glands or ganglia.

The *Lacteal or Chyliferous vessels* commence on the mucous surface of the intestines, pass through the mesenteric glands backwards towards the spine, where they terminate in the thoracic duct.

The *lymphatic vessels* are found in most situations of the body, and generally observe a deep and superficial arrangement.

Lymphatics of the lower extremities.—The superficial set accompany the external and internal saphena veins: they communicate freely in their course with the deep lymphatic trunks which accompany the deep vessels. Those which accompany the external saphena vein enter the glands in the popliteal space, whilst those accompanying the internal saphena vein ascend to the groin, and pass through the inguinal glands, having formed numerous connexions with the superficial lymphatics of the abdomen, the perineum, and the genitals. The deep lymphatics of the hip and perineum are conducted by the branches of the internal iliac vessels into the pelvis, and pass through the pelvic glands. From the inguinal and pelvic glands the lymphatics pass along the primitive iliac vessels to the receptaculum chyli.

The *Thoracic Duct.*—This canal commences by a dilatation called *receptaculum chyli*, placed on the body of the 2d or 3d dorsal vertebra: passing between the crura of the diaphragm it gains the posterior mediastinum, where it lies between the aorta and the vena azygos; at the 5th dorsal vertebra it crosses the spine obliquely to the left side, passing behind the œsophagus and arch of the aorta, and placed behind the left pleura, and between the left carotid and left subclavian arteries, it is then conducted by the œsophagus to the left side of the neck as high as the 6th cervical vertebra, where, making a slight curve downwards and outwards, it opens close to the external angle formed by the left subclavian and jugular veins.

Lymphatics of the upper extremities.—The superficial set accompany the superficial veins, and pass through two or three glands situated at the inner condyle; having joined the deep lymphatics which accompany the venæ comites, they proceed onwards to the axilla, and pass through the axillary glands; following the course of the axillary vein, they pass beneath the clavicle, join the lymphatics of the neck, and terminate in the thoracic duct. The lymphatics of the right upper extremity, and right side of the neck, unite to form the *right or lesser thoracic duct*, which opens into the right vena innominata.

The lymphatics of the trunk consist of a deep and superficial set; in the chest, the former are seated between the muscles and pleura, in the abdomen, between the muscles and peritoneum, the superficial being subcutaneous. The viscera contained in the chest and abdomen also have a superficial and deep layer of lymphatics—the deep being distributed through the peculiar tissue of each organ, the superficial running beneath the membranous envelope.

Lymphatics have been denied to the brain and spinal cord, and to the ear, eye, and placenta. For a beautiful view of lymphatics, see steel plate, Frontispiece.

CHAPTER XIV.

THE SENSES.

THE senses are the means by which the mind becomes acquainted with external objects. Without the materials which they furnish, its exercise would be impossible. When the mind has once experienced various sensations, the memory can recal them when they are gone; the judgment can compare them, and can perceive their relations, and the imagination can combine them into endless varieties; but still, with all this, we are incapable of figuring to ourselves any image, the elements at least of which have not first been made known to us through sensation.

The senses generally enumerated are five, viz.—touch, taste, smell, hearing, and vision. There are other sensations, however, such as those of thirst, hunger, nausea, sneezing, &c., which cannot properly be classed under any of these heads.

TOUCH.

The sense of *touch* is diffused over almost the whole external surface of the body, but is possessed in greatest delicacy by certain parts, such as the lips, and the ends of the fingers. When the innermost layer of the skin is examined with a microscope, it presents numerous projecting points, or papillæ, to each of which it is probable a branch of a sensitive nerve is sent, as they are seen in greatest numbers where the sense is most acute. To exercise this sense in perfection, it is requisite that the organ should be so constructed as to be capable of being readily applied to bodies, in a variety of directions; and it is in the human hand that this quality, the distribution of the sensitive nervous filaments, and a thin cuticle covering these, are united in the highest degree.

The late Dr. Thomas Brown, professor of moral philosophy in Edinburgh, contended that touch gives us no, or at least very imperfect, ideas of extension or space, and of hardness or solidity. Our ideas of these, he thought, are principally derived from what he calls muscular sensations. Connected with this point, we may remark, that Francisco Cæsario, although entirely deprived of sensation on one side, so that even cutting it gave him no feeling, could yet, with the same, judge of the weight and consistence of bodies.

A similar conjecture, as to the feelings derived from temperature, seems to be supported by such cases as the following:—A physician of Geneva, after an attack of palsy, could be pricked or scratched in the right hand or arm, without giving him any sensation. When, however, he took a cold body into his hand, he felt it, but it appeared to him lukewarm. Here the feelings of touch seem to have been lost, but a deranged perception of temperature existed.

The soft bodies of the lowest classes of animals are well fitted for the exercise of the sense of touch, and it is doubtful whether many of them possess any other. The organs of touch in insects, if, indeed, they are not allotted to some higher sense, are especially their antennæ or feelers, which, though in themselves minute, are generally feathered or radiated, so as to include parts too small for human vision, and the sensations of which must be of an exquisitely delicate nature. Huber, in his interesting work on bees, states, that it is by feeling with the antennæ that they seem to direct their various works in the interior of the hive. If an insect be deprived of its antennæ, it either remains motionless, or, if it attempts to fly, appears bewildered. A queen bee thus mutilated, ran about, without apparent object, as if in a state of delirium.

Spallanzani discovered that bats could thread their way with ease through the darkest and most intricate passages, where obstacles had been purposely placed in their way, even when their eyes were put out or covered over, and hence thought that they must have some other sense to direct them. It has been rendered probable, however, that they owe this power to the delicacy of the sense of touch in their wings and other parts.

TASTE AND SMELL.

The senses of *taste* and *smell* may be spoken of together, as they appear in many places to be intimately connected. The sense of taste resides in the tongue and mouth, and has generally been considered by physiologists as little more than a modification of touch. The 5th nerve was supposed to confer both touch and taste. Panizza, however, as was mentioned, has recently disputed this. The papillæ, already spoken of, are particularly well seen in the tongue. If a fluid, such as strong vinegar, be applied with a hair pencil, they will be seen to become curiously elongated.

The tongue is covered with a thin cuticle, and the nostrils are lined by a soft membrane, called, from a celebrated anatomist, the Schneiderian membrane. It is upon this that the olfactory nerve ramifies; not, however, covered by it, but protected from the air that passes through the nostrils merely by the natural secretion, called mucus. The vapor of different bodies thus comes directly into contact with these nerves.

The following Figure shows the olfactory nerves which give the sense of smelling.



Substances tasted must be either naturally fluid, or must be dissolved by the saliva. When this condition is observed, we are sensible of certain feelings, commonly supposed to be produced in

the mouth. A large proportion, however, of the feelings conveyed by the tongue, are little more than different degrees of pungency, which we may almost conceive capable of being felt by the ends of the fingers, had their cuticle been fine enough. The flavor of bodies, generally included when we speak of their taste, is a sensation entirely owing to the action of their vapor on the back part of the nostrils; so that, when the membrane that lines these is inflamed, or otherwise diseased, whiskey, vinegar, mustard, and many other substances, can with some difficulty be distinguished from each other. Any one may easily satisfy himself of the indefinite nature of the sensation of taste, by pushing out the tongue, accurately closing the mouth and nostrils, and then applying it to different substances.

In the savage state, the sense of smell is much used, and becomes proportionately acute. The American Indians, it is said, can easily distinguish different tribes and nations by the odor of their bodies. The blind and deaf boy, James Mitchell, whose history has been recorded by Mr. Wardrop and Professor Dugald Stewart, knew his friends, and at once detected strangers in a room by this sense.

These senses are very acute in some of the lower animals, and particularly in the carnivorous Vertebrata. The olfactory nerves of most birds are small. In the duck and similar tribes, however, they are large, and are much used. The nostrils of fishes do not communicate with the mouth, and smell becomes with them more like taste, from the substance being dissolved in water instead of air.

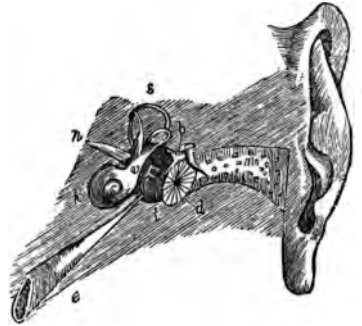
HEARING.

The sense of hearing results from vibrations in an elastic substance, such as air or water, being communicated to the ear. When a bell is shaken in the exhausted receiver of an air-pump, no sound is heard, because the air which usually carries the vibrations to the ear is absent. Sound travels through the air at the rate of about twelve and a half miles in a minute; through water its velocity is four or five times greater; and ice and other solid bodies are known to transmit it even more quickly.

The organ of hearing in man may be divided into external, middle, and internal parts. The external consist of the gristle of the ear (*c*), of use in most animals for collecting the sounds; and of a funnel-shaped canal (*m*), which leads to the middle part or drum (*f*).

The external and middle parts do not communicate directly, there being interposed between the two a thin membrane (*d*), attached to the bony sides of the canal, exactly like the parchment on a real drum. On this membrane the vibrations of the air strike, and to it there is attached a chain of small bones (*b*), which are also connected with the internal ear, in which last is placed the nerve of hearing. The vibrations, therefore, first strike the membrane of the drum, and then pass along these bones to the auditory nerve, seen in the figure, *n*. The cavity of the drum (*t*), though it does not communicate with the external ear, yet has air admitted to it. This passes through a canal (*e*), called the Eustachian tube, which opens into the back part of the throat or pharynx. Most persons have felt their hearing become dull when inflammation of the throat closes this tube, and prevents the passage of the air. The internal ear is very intricate, and the uses of its different parts are not well known. In the figure are seen parts of it called semicircular canals (*s*), the cochlea (*k*), the vestibule (*v*), which are all filled with a fluid, and the auditory nerve (*n*), going to these parts.

The Ear.



c, corcha or external gristle. *m*, canal leading to *t*, the tympanum or drum. *d*, membrane of the drum. *b*, small bone of the drum. *v*, vestibule. *s*, semicircular canals. *k*, cochlea. *n* auditory nerve. *e*, Eustachian tube.

Of the parts described, it would seem that the internal ear is the only one that is essential, for cases have occurred in which disease has destroyed both the membrane of the drum and the small bones, and yet hearing has remained. It is a curious observation, made by Dr. Wollaston, that there are persons, of whom he himself was one, who are insensible to very acute sounds, though all others are perfectly heard. Some cannot hear the note of the bat or the chirp of the grasshopper, while others are insensible even to the chirping of the sparrow.

The Radiata, and almost all the Mollusca, appear to want this sense, but it is possessed acutely by many insects, though the organ used is not accurately known. In the sepia is found the simplest organ of hearing. It is merely a sac filled with fluid, with the nerve expanded in it, and having a hard body attached to its extremity. Fishes have this organ a little more complicated, but in neither these nor the sepia is there any external opening. They hear as we do when a hard body is held between the teeth, the conducting power of water for sound being much greater than that of air. When the Abbé Nollet sank his head under water and struck two stones together, the shock to the ear was almost insupportable. This organ becomes progressively more complicated in reptiles, birds, and the mammalia. Among the last we first find external cartilages, which, as well as the internal tube, are directed forwards in those which pursue their prey, and backwards in timid animals, such as the hare, rabbit, &c.

VISION.

The next and last sense we have to treat of is *vision*. All the affections of this sense are derived from the action of light. We think we see the bodies themselves that are scattered round us, but this is a mistake, for they themselves have no color. The color, or, more properly speaking, the power to produce the sensation we call color, resides entirely in the rays of light that are thrown off or reflected from these bodies to our eyes. In spite of our convictions, however, we cannot help conceiving of our sensations as abiding qualities in these different objects.

If a ray of light be admitted through a small opening into a dark chamber, it appears white, but by causing it to pass through a three-sided piece of glass called a prism, it is seen to be composed of different-colored rays. These, according to Dr. Wollaston, are red, yellowish green, blue, and violet. In this way a ray of light is decomposed; when these colors are all uniformly blended, as when a card on which they are separately painted is rapidly whirled round, the resulting color is again white. Now, it is from the power bodies possess of throwing off or of absorbing special rays out of the number, that they appear to us differently colored. If a body appears blue, the blue rays alone have been reflected; and so on with red, green, and other colors. We do not notice any interval between looking at an object and the impression on our eye (as we can do with distant objects in the case of sound), from the

rapidity with which light travels, and from not having any other sense that can give us information more quickly. There is always an interval, however, and in the case of the distant heavenly bodies this has been calculated. We have said sound travels at the rate of between twelve and thirteen miles in a minute, but light passes through 195,000 miles in the sixtieth part of the same time.

As the eye is strictly an optical instrument, we must state that it is a law of optics that the rays of light, while passing through the same medium, proceed in straight lines, but that they are turned out of their course when they pass from a less into a more dense medium. They are then said to be refracted. This takes place when the rays of light pass from air into water, and it is by virtue of the same law that a common magnifying or double convex glass collects the sun's rays into a focus or point.

The eye has various appendages, which require some explanation. The first to be noticed are the eyelids. These are composed chiefly of a gristly substance placed under the skin that accurately fits the ball of the eye, and which is lined internally by a thin membrane called the conjunctiva, that turns over on the globe of the eye, and keeps it in its socket. Attached to the eyelids are the eyelashes, which protect the eye from too great a glare of light, from particles of dust, &c. Persons without eyelashes have always tender eyes. The chief purposes served by the eyelids are, 1st, to protect from external injury, and to exclude the light when they are closed; and, 2dly, to distribute equally over the eyeball the fluid which moistens it. This fluid is usually carried off as quickly as it is formed; but when the eye is irritated, or the mind affected by various emotions, it is then secreted in such quantity as to run over the eyelids in the form of tears. The source of this fluid is a gland, named the lachrymal gland, situated above the outer angle of the eye. Tears, there secreted, pass downwards to the eye, whence they flow, through two small holes (*puncta lachrymalia*) near the inner angle of the eyelids, into a small receptacle called the lachrymal sac, placed immediately behind the inner angle, and from which there is a communication to the nostrils by what is called the nasal duct. This is the reason why, when tears are copious, a necessity for blowing the nose is felt. When the nasal duct is obstructed, as often happens, the nostril on that side is dry, and the tears run over the eyelids. The *puncta lachrymalia* may easily be seen by everting the eyelids, and looking at their inner angle; and the opening of the nasal duct may be seen by look-

ing into the nostril of the horse. The two edges of the eyelids, when closed, form a channel, along which the tears flow. Birds have a third eyelid, at the inner angle of the two others, which they may often be seen moving. Fishes have neither eyelids nor lachrymal apparatus.

Others of the appendages are the muscles that move the eye, six in number. There are, besides these, two that move the eyelids. A broad circular one, which closes the eyelids, lies immediately under the skin. The other, which raises the upper eyelid, is a long muscle, and is attached to the bone deep behind the eyeball.

We now come to consider the globe of the eye, the parts composing which are seen in the following figure, representing a horizontal section of it. C, the cornea, is the transparent part of the eye in front, which, it will be seen, forms part of a lesser circle, and therefore projects more than the rest of the globe. It is set into the white part of the ball of the eye, and after steeping, can be taken out of it like a watch-glass. S, the sclerotic or hard coat, is the outermost one, or the white part of the eye seen in front. It extends over the whole ball posteriorly, and, from its toughness, forms its principal support. In the tortoise and in birds, this part anteriorly has bony matter in its composition; and in the immense eye of the extinct reptile called the ichthyosaurus, it appears to have been composed of bony plates. The coat (X), which lies internal to the sclerotic, is called the choroid coat. It is lined on its inner surface, in the human eye, by a brownish-black paint (contained in hexagonal cells), which we see when we look deep into the eye. Its use seems to be to absorb the rays of light not required in vision. The color of this paint is, as every one has seen, yellowish-green in the eye of the cat. It is chocolate-brown in the hare and rabbit, silvery-blue in the horse, and pale golden yellow in the lion and bear. In general it is of a light shade in such animals as prow by night. This paint is wanting altogether in albino animals, such as white rabbits or ferrets, and the red blood-vessels can then be seen in the eye. This coat seems to be continuous with a number of foldings called ciliary processes (K). The innermost of the coats of the eye (R) is called the retina, from its netted appearance. It consists of a very fine membrane, with the pulpy, half transparent substance, which is continuous with the optic nerve (O), expanded upon it. This is the seat of vision. All visual impressions must, in the first place, be made upon this expansion, and are then conveyed by the optic nerve to the mind.

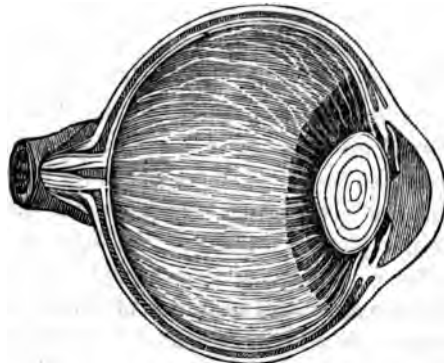
Human Eye Dissected.



C cornea. S, sclerotic coat. X, choroid coat. R, retina. O, optic nerve. V, vitreous humor. L, lens. A, aqueous humor. P, pupil. J, iris. K, ciliary processes.

The parts of the eye remaining to be described are the humors and the iris. A is the aqueous or watery humor, placed immediately behind (C) the cornea. It is divided into an anterior and a posterior chamber by (J) the iris, which floats like a curtain in it. The iris is the part that gives the blue, grey, or black color to our eyes, and which has in its centre an opening (P) that enlarges or contracts according to the quantity of light to be admitted. It is supposed to possess a circular and a radiated set of fibres to effect this. Behind the aqueous humor lies the lens (L), the firmest of the three humors. Its form in the human eye, as seen in the figure, is something like a highly convex magnifying-glass. In fishes it is globular, and it is it that falls out like a pea when the eye is boiled.

Horizontal section of the Eye, showing the different humors.



Behind this, again, is placed the largest or vitreous humor (V), which appears of rather greater consistence than the white of an

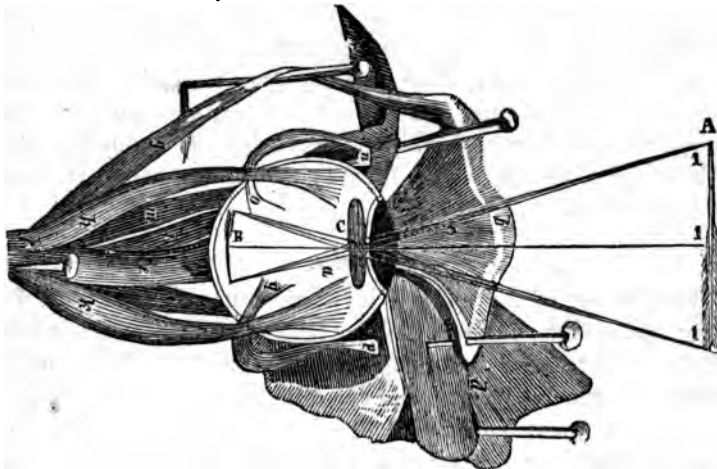
egg, and is enclosed in a very fine transparent membrane, ramifying also into its interior, as in the foregoing figure.

By the united action of all these parts, vision is produced. The cornea serves the purpose of a convex or magnifying glass, to collect into foci or points the rays of light that pass from an object to the eye, and this effect is still further assisted by the lens placed behind it. The point where these foci are thus formed, is the retina; and the eye may be compared to the optical instrument called the camera obscura, which is, indeed, but an imitation of the eye itself. Those who have seen this instrument will know, that when the part corresponding to the cornea is presented to a landscape, there is an exact picture of it formed on the back part of the box. Kepler, the great astronomer, made the interesting discovery that the same thing may be seen in the eye. If the eye of a recently killed bullock be carefully stripped of its sclerotic and choroid coats posteriorly, and the retina be supported by a piece of transparent silk, it may be placed in the hole of a window shutter looking out upon a landscape, and a diminutive but distinct picture of the whole may be seen depicted on the retina. From the thinness of the coverings of the eye in albino animals (such as the white rabbit), this exquisitely beautiful experiment may be performed even without removing any of the coats.

It is truly wonderful to think that all the accurate perceptions of this sense are derived from the images of a crowded picture formed at the bottom of the eye, on a space so small that it may be covered with the point of the finger. What can be more astonishing than the fact, that the image of the sail of a windmill, six feet in length, seen at the distance of twelve paces, occupies only the twentieth part of an inch on the retina, and that the image of the same sail, when removed to the limits of distinct vision, occupies, according to the calculations of M. de la Hire, only the eight thousandth part of an inch, or less than the sixtieth part of the breadth of a common hair! "We can never," to quote again Dr. Paley's words, "reflect without wonder upon the smallness yet correctness of the picture formed at the bottom of the eye. A landscape, of five or six square leagues, is brought into a space of half an inch diameter, yet the multitude of objects which it contains are all preserved—are all discriminated in their magnitudes, positions, figures, colors. A prospect is compressed into a compass of a sixpence, yet circumstantially represented. A stage-coach, travelling at its ordinary speed for half an hour, passes in the eye over only

one-twelfth of an inch ; yet is this change of image distinctly perceived throughout its whole progress, for it is only by means of that perception that the motion of the coach itself is made sensible to the eye." How minute must be the object of man as represented in the retina of a humming bird ?

THE EYE.



a, represents the eyeball. C, the crystalline lens, where the rays of light, 1 1 1, from A, the arrow, meet like a sun-glass and diverge, or are refracted and thrown on the retina B, which represents the object absolutely perfect, though extremely small. e, the optic nerve, conveys it to the brain, and gives it a knowledge of the above object. 1 1 1, rays of light from an arrow, which pass through C, the crystalline lens, by which they are concentrated the same as in a sun-glass, in front, and refracted by the concavity of it on the back, and thrown on the retina B, which ought to be a little further back. Here the object is formed. The other letters represent the different muscles of the eye.

After what has already been said of the proofs of design furnished by other parts of the body, it is almost unnecessary, in that point of view, to direct attention to this admirable organ. Its mechanism is so clear that no man can mistake its objects. A celebrated philosopher held (and with good reason) that an examination of the eye was a cure for atheism ; and he might have added, that it not only proves, beyond all doubt, the existence of a great first cause, but also, perhaps, more than any other organ, that our Creator's design is to mingle pleasure with our existence. If only what was necessary had been done, it has been well remarked, that nothing but the tame, dull outlines of objects might have been made sensible to us. But color, endless in its shades, ever variegated in its tints, has been spread over the face of nature—with what purpose, it may be asked, if not to convey to us delight, and to prove that He who made us,

also wishes us to be happy. But, after all, it would appear that we cannot use that happiness, or much of it, without first having passed through great sufferings, the lot of all mortals.

Among even the lower tribes of the Radiata, indications of sensibility to light have been observed, but no distinct organs for this sense have been discovered. Ehrenberg has lately described some small spots in the rays of the star-fish, which he conceives answer the purpose of the organs of vision. As we rise higher, visual organs are seen, but the Sepia is the lowest that has eyes constructed like those of the Vertebrata. The eyes of insects are called compound, being, in truth, immense aggregations of eyes, apparently to compensate for their want of mobility. The common house-fly has 8,000 of these eyes; the dragon-fly, 12,544; and some other species have upwards of 25,000.

DISEASES.

The diseases of the eye are very numerous. The conjunctiva, lining the eyelids, and reflected on the eyeball, the sclerotic coat, and the iris, are particularly liable to inflammation. The purulent ophthalmia generally commences in the conjunctiva, and destroys the eyes of great numbers. The lens often becomes opaque, especially in old people, and causes blindness. When this happens, it is called cataract, and very frequently an operation is performed to restore vision. Blindness also arises from opacity of the cornea, closure of the pupil, disease of the retina or optic nerve, called amaurosis, &c.*

* The operation for cataracts, instead of restoring the sight, generally destroys it, and extends inflammation to the other eye. One surgeon says he spoiled a *hat-full of eyes* before he could operate successfully. He should have added, "and then could not succeed in effecting a cure." It appears unreasonable to run an instrument into the ball of the eye, and thus let out the humors, and cause inflammation, to remove blindness. It appears to me, from pretty extensive experience and observation, that the means made use of in diseases of the eye, are calculated to injure instead of benefiting them. In inflammation, scarifying and cupping the eyes are practised, blistering, mercury, blue vitriol, &c., &c.; all this barbarous and empirical practice is sufficient to cause blindness in the eyes of those which are sound, and which, no doubt, is often done. And yet we build asylums for the blind, and we feel great compassion for the inmates. Now, would it not be much more wise to pass laws to suppress this woful quackery of our "surgeons" and "oculists," and thus prevent the evil and misfortune of those made blind by their malpractice, in place of allowing them to use absurd and dangerous means calculated to induce, instead of removing, blindness. But the major part of the community are so stupid, prejudiced, and intellectually *blind* on the subject, that we despair of a remedy, unless they or their posterity become more enlightened, if not more honest. I believe if diseases of the eyes were taken in time, and prudently treated, seldom a case of blindness would ever be seen.

THE MIND.

In concluding this chapter, I will add a few remarks on the mind, this wonderful, unknown, mysterious, immortal principle, so intimately connected with the body.

With the operations of animals, who always perform the same work in the very same manner—the execution of any individual being neither better nor worse than that of any other; in whom the individual, at the end of some months, is what he will remain through life, and the species, after a thousand years, just what it was in the first year—contrast the results of human industry and invention, and the fruits of that perfectibility which characterizes both the species and individual. By the intelligence of man the animals have been subdued, tamed, and reduced to slavery; by his labors, marshes have been drained, rivers confined, their cataracts effaced, forests cleared, and the earth cultivated. By his reflection, time has been computed, space measured, the celestial motions recognised and represented, the heavens and the earth compared. He has not merely executed, but has executed with the utmost accuracy, the apparently impracticable tasks assigned him by the poet:—

Go, wondrous creature! mount where science guides;
Weigh air, measure earth, and calculate the tides.

By human art, which is an emanation of science, mountains have been overcome, and the seas have been traversed; the pilot pursuing his course on the ocean, with as much certainty as if it had been traced for him by engineers, and finding at each moment the exact point of the globe on which he is, by means of astronomical tables. Thus nations have been united; and a new world has been discovered, opening such a field for the unfettered and uncorrupted energies of our race, that the senses are confused, the mind dazzled, and judgment and calculation almost suspended by the grandeur and brightness of the glorious and interminable prospects. The whole face of the earth at present exhibits the works of human power, which, though subordinate to that of nature, often exceeds, at least so wonderfully seconds her operations, that, by aid of man, her

Treatment.—In inflammation of the eyes, which in nearly every case precedes blindness, means should be taken to reduce or moderate it by *cathartics*, and *forcing* the blood from the head and eyes to the *extremities* and *surface*. *Elm bark* and *cooling washes* to the eyes, are well calculated to fulfil these intentions. In order to dispense with spectacles and preserve the sight, wash them night and morning with cold water and a little *white castile soap*; and more than all, keep clear of the surgeon and professed oculist, except you wish your eyes destroyed.

whole extent is unfolded, and she has gradually arrived at that point of perfection and magnificence in which we now behold her.

In the point of view which I have just considered, man stands alone: his faculties, and what he has effected by them, place him at a wide interval from all animals—at an interval which no animal hitherto known to us can fill up. The manlike monkey, the almost reasonable elephant, the docile dog, the sagacious beaver, the industrious bee, cannot be compared to him. In none of these instances is there any progress either in the individuals or the species.

In most of the feelings of which other individuals of the species are the subjects, and in all which come under the denomination of moral sentiments, there is a marked difference between man and animals, and a decided inferiority of the latter. The attachment of the mother to the offspring, so long as its wants and feebleness require her aid and defence, seems as strong in the animal as in the human being, and bears equally in both the characters of actions termed instinctive. Its duration is confined in the former case, even in social animals, to the period of helplessness; and the animal instinct is not succeeded, as in man, by that continued intercourse of affection and kind offices, and those endearing relations, which constitute the most exalted pleasures of human life. In a word, as a writer has said: We can almost make the marble speak; and since this was uttered has it not been realized in the machine invented by a German, which articulates words, or talks by means of keys, or machinery.

[ILLUSTRATIONS.—To illustrate the sense of smell, a longitudinal section of the nose of a sheep can be easily made, keeping the saw as much as possible to one side, when the spongy or turbinated bones, which are covered with the Schneiderian membrane, and are convoluted to increase the extent of surface, may be observed. The structure of the nose of the cod or haddock is also curious. It does not communicate with the mouth, and ought to be shown. The olfactory nerves going to it from the brain, may easily be exposed in the fish with a strong pair of scissors.

The organ of hearing lies deep in the bone, and is not easily got at. However, the membrane of the drum in a sheep can be very nicely shown, by taking off the bone containing the ear from the skull, and then cutting away the external bony canal leading to it, until it is exposed. The small bones of the ear may also be obtained by breaking into the drum with a strong pair of cutting pliers. They should be taken out, and fastened with gum on a card covered with a piece of black velvet.

A simple apparatus to show the vibrations of the air, in imitation of the external ear, may be constructed by forming two pieces of firm pasteboard into a shape like a common funnel used for decanting liquors, cutting the narrower extremity slopingly, so as to leave an opening about two inches by one and a half, and gumming *loosely* over this a piece of goldbeater's skin. The other extremity may be made about seven inches in



William Daniel. Sculp.

1 Lymphatic vessels. 2 Heart. 3 Lungs. 4 Liver.
5 Stomach. 6 Lumbar regions. 7 Uterus. 8.8 Ovaries.



diameter. When this funnel is supported on a wire-stand, so as to bring the gold-beater's skin into a horizontal position, and some fine sand is placed on it, the vibrations produced by the air may be seen, by beating on a sheet of tin, or other strongly vibrating body, at the larger extremity. Any tinsmith will give the shape for the paste-board.

The structure of the eye can be admirably shown. Direct attention to the puncta lachrymalia; to the appearance of the pupil, contracting and dilating as more or less light is directed on the eye; to the correspondence of the motions of the two eyes; the color of the iris, &c. The muscles of the eyeball can be beautifully seen in the sheep, but they require a good deal of dissection. The globe of the eye may be easily shown, however. Get a bullock's or sheep's eye, clear off the fat, &c., and observe the optic nerve entering it posteriorly. Take hold of the optic nerve, introduce a pair of sharp scissors through its coats, rather more posteriorly than the middle of the globe, and cut the coats round transversely. The exterior sclerotic coat, the pulpy retina (often curled up) interiorly, and the choroid coat between these, will then be seen. Some of the vitreous humor will probably escape in making the section, and both it and the lens, lying behind the pupil, will be seen when the posterior section of the eye is removed. A number of lines on the choroid coat, radiating from the circumference of the lens, and called ciliary processes, may also be seen. The aqueous humor may be seen to escape when the eye is made tense (when entire), and the cornea is punctured. The iris may be examined when the humors are removed. A similar section of a cod's eye should be made to show the globular lens. The eye of a fowl may also be examined, and its bony sclerotic, third eyelid, &c., observed.

Such a section as has been mentioned should, of course, always be made, but the anatomy of the eye is made much more simple by having a horizontal section model of it. In this its coats, humors, &c., are all seen, and their relations may be comprehended with the utmost ease by young students.

To show the inverted image on the retina, the eye of a white rabbit answers well. It is seen best by candle light, and when two or three lights are moved before the eye. All the muscles and fat must first, of course, be removed posteriorly.

A prism, to show the decomposition of light, and a small camera obscura, should be exhibited.

For figures to illustrate this chapter, see Lizars' Colored Plates, pages 75, 76; Roget's Bridgewater Treatise, vol. ii., pages 384, 400, 401, 425, 464, 467.]

CHAPTER XIV.

THE TEMPERAMENTS.

THERE are four of these: 1st, The *lymphatic*, in which there is easily seen a full, soft, and rounded form, and languid action.

2d, The *sanguine*, in which there is a florid complexion, expanded chest, and general vivacity of disposition, showing the preponderance of the vascular system, known generally by the term of plethoric or full habit, the circulation of the blood being very full and strong.

3d, The *bilious*, in which the muscular system predominates. The body is remarkable for compactness of fibre, indicative of strength and activity.

4th, The *nervous*, in which there is a thin, sharp outline, irregular and vivacious activity, and great susceptibility of impressions, and which betoken the predominance of the nervous over all the other functions. Says Shakspeare—

Let me have men about me that are fat ;
Sleek-headed men, and such as sleep o' nights ;
Yond' Cassius has a lean and hungry look ;
He thinks too much ; such men are dangerous.

The following figures represent the different temperaments :—

FIG. 18. LYMPHATIC.

FIG. 19. SANGUINE.



FIG. 20. BILIOUS.



FIG. 21. NERVOUS.



The following Figures represent the facial angles of different nations according to Camper :—



Head of the Negro (some races)



Orang



Ancient Greek Statue.



European.

APPENDIX.

PHRENOLOGY.*

I subjoin a few remarks on Phrenology.

DEFINITION.—Phrenology points out those connexions and relations which exist between the *conditions and developments of the BRAIN*, and the *manifestations of the MIND*, discovering each from an observation of the other. Its one distinctive characteristic feature is, that each class of mental functions is manifested by means of a given portion of the brain, called an organ, the size of which is the measure of the power of function. Thus the benevolent feeling is manifested and indicated by means of brain in the frontal part of the top of the head, and in proportion to the development of brain here, will be one's spontaneous flow of kind, obliging feeling, and so of every other quality of mind.

I am indebted to my friend Mr. Wells for the following cut of the phrenological organs.



* Derived from the two Greek words, "Phren," which signifies mind, and "Logos," discourse; the two together signifying the science of mind, or its laws and phenomena, as manifested through the brain.

ARRANGEMENT, NUMBERING, AND DEFINITION OF THE FACULTIES.

1. **AMATIVENESS**—Love and attraction between the sexes as such; desire of coition; also, to caress, pet, and fondle.
2. **PHILOPROGENITIVENESS**—Parental love, regard for children, pets, and animals, and desire for their welfare.
3. **ADHESIVENESS**—Friendship, attachment, affection, desire for society, association, and social enjoyment.
- A. **UNION FOR LIFE**—Desire to pair, to unite, and be in the constant society of, those whom we love.
4. **INHABITIVENESS**—Love of place, desire for a permanent homestead and residence, to work and live in one place.
5. **CONCENTRATIVENESS**—Unity and continuity of thought and feeling; tendency to dwell upon one subject.
6. **COMBATIVENESS**—Resistance, self-protection; spirit of opposition, resolution; disposition to brave danger.
7. **DESTRUCTIVENESS**—Executiveness, indignation, irritability, a destroying and pain-causing disposition; energy.
8. **ALIMENTATIVENESS**—Appetite, desire of nutrition, sense of hunger, and capacity to enjoy food and drink.
9. **ACQUISITIVENESS**—Desire to acquire and possess property as such; its exercise tends to frugality and industry.
10. **SECRETIVENESS**—Sense of secrecy, concealment, cunning, evasion; disguising one's real sentiments and plans.
11. **CAUTIOUSNESS**—Sense of danger; apprehension, delay, regard for present and future safety; fear, dread of results.
12. **APPROBATIVENESS**—Sense of character and appearance; desire to please, love of praise and popularity; vanity.
13. **SELF-ESTEEM**—Self-regard; pride, independence, dignity; love of power and distinction; self-reliance.
14. **FIRMNESS**—Decision, will, perseverance, stability, determination of purpose; unwillingness to yield.
15. **CONSCIENTIOUSNESS**—Sense of moral obligation; regard for truth and justice; contrition, integrity, honesty, &c.
- C. **CIRCUMSPECTION**—Sense of discretion, consistency, uniformity, and balancing power—[not fully established.]
16. **HOPE**—Sense of immortality, and of the future; anticipation, expectation; looking forward for future results.
17. **MARVELLOUSNESS**—Credulity; sense of the spiritual and supernatural; belief in invisible agency; faith, curiosity.
18. **VENERATION**—Sense of greatness; adoration; respect for superiority, authority, and deference to age or antiquity.
19. **BENEVOLENCE**—Munificence, sympathy, disinterestedness, and desire to promote the happiness of others.
20. **CONSTRUCTIVENESS**—Sense of mechanism, manual dexterity, contrivance, ingenuity, and skill.
21. **IDEALITY**—Sense of perfection; delicacy, taste, refinement, appreciation of the beautiful in nature and art.
- E. **SUBLIMITY**—Sense of the vast, the grand, and the sublime in nature; love of the highest kinds of composition.
22. **IMITATION**—Powers of representation, limitation, and adaptation; versatility of action; ability to mimic others.

22. **MIRTHFULNESS**—Perception of the absurd and ridiculous; gaiety, levity, playfulness, and buffoonery.
24. **INDIVIDUALITY**—Power to identify individual objects; observation of details; desire to be an eye-witness.
25. **FORM**—Sense of shape, likeness, expression, and outline; memory of countenances and configuration.
26. **SIZE**—Sense of proportion, magnitude, and equality; and relation of outlines: exactitude.
27. **WEIGHT**—Sense of gravity; power to balance, and apply the laws of gravity in machinery and muscular motion.
28. **COLOR**—Sense of colors; their beauty, arrangement, and harmony in nature and painting.
29. **ORDER**—Sense of, and desire for convenience and arrangement; neatness—perception of general economy.
30. **CALCULATION**—Perception of numbers, and their relations—numerical computations.
31. **LOCALITY**—Sense of place, position, and direction; memory of objects by location; desire to travel, see places, &c.
32. **EVENTUALITY**—Sense of action, events, phenomena, statistical knowledge; memory of facts; love of narrative.
33. **TIME**—Sense of chronology, of duration, of passing time; when, and how long; equality in step and beat in music.
34. **TUNE**—Perception of sound, of melody, of proper emphasis, and modulation of the voice; ability to compose music.
35. **LANGUAGE**—Sense of words or signs to communicate ideas; ability to talk; memory of words and names.
36. **CAUSALITY**—Sense of cause and effect; power of abstract thought, penetration, planning, invention, originality.
37. **COMPARISON**—Sense of resemblance, of analogies, similes, and power of analysis; association, comparison, &c.

The celebrated Alexander Campbell, founder of the, Campbellite Baptists, was examined by Mr. Fowler. After which he addressed him the following letter, corroborating the correctness of the examination:—

New York, May 3, 1847.

MR. N. L. FOWLER:—

“*Dear Sir,*—When, at the request of Mrs. Campbell, one of your readers, I called at your office, without in any way making myself known to you, simply saying that I had, at the request of a friend, called upon you to obtain a chart of my head, I little expected to hear you so soon begin to tell me your views of my physiological and mental character, and describe, with such remarkable exactness, what I knew of myself—two or three points, at most, out of some twenty or more prominent characteristics of both, only excepted. Had I had any doubts of the general principles of the science being founded on facts, and facts well-arranged, I should have been delivered of them all, so far as my own knowledge of myself will justify me in forming an estimate of the different attributes you noted in my physiological and mental constitution.

“I am not one of these who imagine that any science, and still less that of the human mind, or of human nature, can in a few years, or by one class of contemporary minds, be completely and perfectly developed and matured. I am, therefore, of the opinion, that the Science of Phrenology is but in progress, and not yet perfected; but that it should have, in so few years, and in defiance of the hoary and consecrated systems of metaphysical science arrayed against it, and sustained by names the most admired and revered in Christendom, attained its present state of perfection, is truly wonderful, and

characteristic of the rapid march of all sorts of improvement in this truly inquisitive and ambitious age.

"I have been frequently solicited by friends who are amateurs in the science, to allow them to give me a chart of my head. Their reports were, in the main, generally conformable to my knowledge of myself; but their previous knowledge of my character was always such as to leave some dubiety whether they did not correct their Phrenology from their memory or acquaintance with me, rather than simply utter the revelations of the cranium. Your having no advantage of this sort, has given to your details a value paramount to those of any other phrenologist with whom I have been conversant; and I cannot but admire the science which bestows upon its possessor the power thus to develop the human mind, and to advance the cause of education, physical, and intellectual, and moral. Please accept my thanks for the copy which you have sent me of what you said to me, almost off-hand, with my wishes for your success in all your endeavors to further the cause of a rational education, to improve the human constitution, and to increase the social happiness of our species.

"Respectfully, your obedient servant,

"A. CAMPBELL."

MESMERISM.

A FEW remarks on that functional state of the nervous system, termed Mesmerism, may not be irrelevant to add in this treatise. It is called by some animal or human magnetism. It was known to the ancients, and has been revived by the moderns,* particularly in the last century by Dr. Frederick Antony Mesmer, of France, from whom it has derived its name. Under the name of "neurology," attempts have been made in this country to put a new dress upon it, and to bring it before the public with new features, and to connect with it some new discoveries; but it remains to be what it has ever been, the principal difference being only different modes of illustration.

Of the nature of this mysterious principle or agent, we know but little, but of its effects on the system we are quite familiar; and it can be practised and demonstrated easily by any one a little acquainted with the method of operating upon those termed "impressible subjects." After repeated passes of the hand from the head downwards nearly in contact with the body, the subject falls into a mesmeric sleep, formerly called the *crisis*, in which the outward senses, particularly the sight, are apparently closed, and the interior, or inward senses, are capable of seeing and describing objects not otherwise visible—as internal diseases, reading when blindfolded, &c. The body sometimes becomes fixed as in a trance, and is insensible to pain, so that even surgical operations have been performed in a magnetic sleep without causing distress.

A limb having been mesmerized, becomes stiff and almost immovable, and may be made to adhere firmly to the head, so that it cannot be forced off until the fluid has been withdrawn. The will of the person magnetized appears to be completely under the direction of the magnetizer. In this condition, if any of the phrenological organs are magnetized, it develops their peculiar character, and the subject involuntarily exercises them preternaturally; for instance, *combativeness*, which arouses the pugnacious or fighting propensities; if *amativeness*, the subject makes loves to the operator. Some who make extravagant if not visionary pretensions to magnetism, assert that by putting certain agents into the hand, such as Capsicum, Antimony, &c., their effects will be felt.

* Travellers in eastern countries describe paintings found in the temples of Thebes and other ancient cities which represent persons in a sleeping posture, while others are making passes over them. The priests of Chaldea, of Nineveh, of Babylon, of Judea, and Jerusalem, and the priests and physicians of ancient Greece and Rome practised magnetism in their temples and in the healing art, long before the Christian era. "Aristotle informs us that Thales, who lived six hundred years before Christ, ascribed the curative properties in the magnet to a soul with which he supposed it to be endowed, and without which he also supposed no kind of motion could take place. Pliny also affirms the magnet to be useful in curing diseases of the eyes, scalds, and burns; and Celsus, a philosopher of the first century after Christ, speaks of a physician by the name of Asclepiades, who soothed the ravings of the insane by manipulations, and he adds that his manual operations, when continued for some time, produced a degree of sleep or lethargy."

upon the system; and no doubt those who have the organ of *marvellousness* largely developed suppose that some such effect is produced, with other strange fancies.

The question naturally arises, How far is it useful? This remains yet to be shown. Some attach great remedial power to magnetism, and, no doubt, in some cases, it exerts an influence, and may have proved useful; but as yet nothing very definite or certain has been established that we can rely upon. It would appear that those termed "clair voyants" are able to detect diseases, but most of them are unable to prescribe successfully, as I have proved in my practice. How far this agent will be more fully developed remains to be seen. But probably much greater light will be thrown upon it by future investigations. Without doubt all the phenomena are to be referred to natural causes, and not to superhuman or satanic agency, as has been supposed.

Some err, if not degrade themselves, by the false and visionary ideas they attach to magnetism. They make it their "hobby," and much of their ideality is associated with its wonderful effects on the system. To listen to them, we would suppose that their claims to discoveries were superior to all others. This manifests a peculiar state of mind bordering on *monomania*, and the healing art at least will not be much indebted to such for improvements.

The subject of animal magnetism now excites considerable interest in England and India, and some experiments have been made which illustrate very clearly its singular effects upon the system. Institutions and periodicals have been established to promote it, particularly among the poor, as a medical agent. A mesmeric infirmary has been established for the poor in Dublin, and one in *Madras*, in *India*, called the *Eclectic Mesmeric Hospital*. The British government has appointed a committee to investigate its merits. The resident surgeon has reported several operations performed on native patients for large tumors, which were removed without pain in the *mesmeric trance*, weighing from thirty to a hundred pounds. Dr. Esdaile, one of the surgeons of the institutions in India, closes the report on the effects of mesmerism in the following language:—

"From the foregoing facts, I consider myself entitled to say that it has been demonstrated that patients in the mesmeric trance may be insensible to,

"1st, The loudest noises.

"2d, Painful pricking and pinching.

"3d, The cutting of inflamed parts.

"4th, The application of nitric acid to raw surfaces.

"5th, The racking of the electro-magnetic machine.

"6th, The most painful surgical operation, and yet be aroused into full consciousness by the exposure of the naked bodies for a few minutes to the cold air.

(Signed)

"JAMES ESDAILE, M.D.

"Calcutta, 1st January, 1847."

The following figure, which I have had engraved from an old English author, represents strikingly the method of operating at that day with the costume then worn.



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